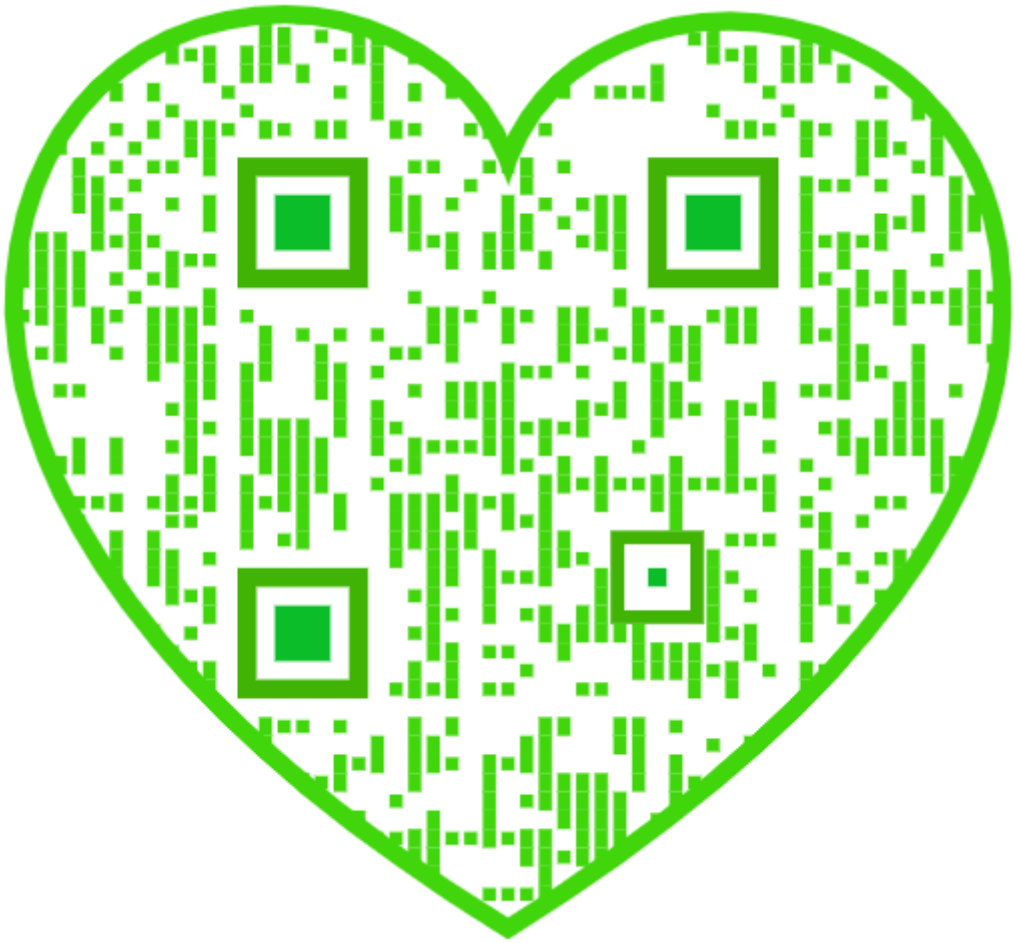

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DYEING:

COMPRISING

THE DYEING AND BLEACHING OF WOOL, SILK, COTTON, FLAX, HEMP, CHINA GRASS, &c.

BY

ANTONIO SANSONE,

Author of "The Printing of Cotton Fabrics," leading Contributor to the Colourist Section of "The Textile Manufacturer," late Director of the School of Dyeing at the Manchester Technical School.

Illustrated with numerous Plates and Specimens.

Manchester:
ABEL HEYWOOD & SON, 56 & 58, OLDHAM STREET.
London:
SIMPKIN, MARSHALL, & CO., STATIONERS' HALL COURT;
HAMILTON ADAMS, & CO., 32, PATERNOSTER ROW.
1888.

Abel Heywood & Son,
Printers,
Oldham Street, Manchester.

PREFACE.

In publishing this volume, which may be considered as a complement to my first work—"The Printing of Cotton Fabrics," I have tried to give as complete an account as possible of the present state of the Dyeing Industries.

All the information has been brought up to date by the untiring kindness of the manufacturers of dyestuffs and machinery makers, to whom I am under great obligations.

Owing to their kind support I have been enabled to give a greater number of illustrations of machinery than I at first intended.

The number of patterns which have been also so plentifully contributed by several firms have been gradually growing up to such an extent that it has been deemed necessary to form the pattern cards into a second volume.

I must here express my thanks to all those firms and gentlemen who have helped me in the publication of this work.

Manchester, July, 1888.

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HISTORY OF DYEING.

CHAPTER I.

The art of dyeing seems to have been practised from remote antiquity, and may be said to be as old as civilisation itself. The most ancient historical records we have respecting dyeing date from the time of the Phœnicians, about 14 or 15 centuries B.C. This people seem to have brought the art to a high degree of perfection, if we may judge from the accounts preserved in history, especially in regard to the famous Tyrian purple, a very costly dye, which was applied on wool, and which, according to Pliny and Aristotle, was obtained from a species of mollusc. This dye was so highly prized, that even in the time of Augustus one pound of wool dyed with the Tyrian purple sold for the then enormous price of 1000 denarii, or about £36 sterling. The material so dyed was only worn by those invested with the highest dignities, and severe penalties, extending under the late emperors even to death, were inflicted on those who presumed to wear the purple without occupying these high positions.

The Egyptians had good knowledge of dyeing, and were even acquainted with the employment of indigo, evidence for this fact being furnished by their dyed mummy bandages, some of which are preserved in the British and other Museums. It is very likely that metallic salts, such as copperas and alum, were also known to the Egyptians, who no doubt derived the knowledge of dyeing and other useful arts from India, which country may be considered the birthplace both of dyeing, and, later on, of the art of staining fabrics. Although no direct historical records exist to prove this, there seems nevertheless to be no doubt that

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the Egyptians derived their knowledge of dyeing and staining principally from Hindostan, where the art had been practised for many centuries.

Although the ancient Greeks derived their civilisation in a great degree from the Egyptians, yet in the art of dyeing they do not seem to have acquired much proficiency; at any rate they did not go so far as the Romans, who brought the art to greater perfection, and who, it has been proved, were acquainted with the use of madder, woad, nutgalls, alkanet roots, alum, blue and green vitriol, and even with certain lead salts.

The Chinese do not appear to have practised the art of dyeing to any great extent, until they derived a more thorough knowledge of it from the Hindoos and the Persians. India and Persia attained in ancient times a very high degree of civilisation, and the art of dyeing spread from them westward to Egypt, and thence to Greece and to Rome.

At the fall of the Roman Empire, through the overrunning of Italy by the barbarians, all progress in the sciences and arts was stopped, and the knowledge and experience therein originally possessed by the Romans seems to have been almost entirely lost during the fifth century. A little, however, was still preserved in Italy, and was afterwards developed in Venice, where, through the increase in the commerce—principally with the Orient—of that republic, the arts were afterwards brought to a high degree of development. While at the fall of the Roman power all Europe was thrown into darkness, the Moors or Saracens attained a high degree of civilisation, and brought their arts and manufactures, such as paper making and the extraction and use of dyes, to a very forward state. They were most likely acquainted with the so-called Turkey red dyeing, which was so skilfully carried on at Adrianopolis in Turkey. These Saracens or Arabs were also the means of re-introducing the sciences and arts into Europe.

At the time of the Crusades, the Christians brought back from the Holy Land the arts of the East, and by reason of

the increased importance of the commerce of Venice and of the other republics of Italy, the manufactures and the arts of dyeing were greatly developed in the peninsula, Venice, Florence, and Genoa becoming famous for their productions in this line. In the 14th century Florence possessed over 200 dyeworks, and Archil or Roccella must have been extensively employed, as a street was called after its name Strada de Roccellarii. It is interesting to note that in 1429 the first collection of processes used in dyeing was published in Venice under the title of *Mariegola dell'Arte dei Tintori*, and that a second and improved edition of the work appeared in 1510. An Italian, Giovanni Ventura Rossetti, after travelling a great deal through Italy and other countries, also published a work under the title, *Plictho dell'Arte dei Tintori*, &c., dated 1548.

From Italy the art of dyeing and other manufactures spread over Europe, and penetrated into England by way of France. The first account published in the English language of the methods and operations used by dyers seems to be that contained in Dr. Spratt's "History of the Royal Society," being a paper by Sir William Petty, entitled "An Appendix to the History of the Common Practices of Dyeing." In France a great impetus was given by Colbert to the industrial arts, and dyeing attracted the special attention of that great minister, who caused a work to be printed under his special supervision, entitled *Instruction générale pour la teinture des Laines et Manufactures de Laine de toutes nuances et pour la culture des drogues et ingredients qu'on employe.* This work, which had been especially prepared in order to prevent frauds in the practice of dyeing, is divided into two parts: *grand teint* and *petit teint*—fast and loose colours.

France since Colbert's time has done a great deal towards the progress of the tinctorial arts by the researches of her distinguished chemists and men of science, who have devoted themselves to this branch of industry.

The discovery of America helped considerably towards the development of the dyeing industries, as new colouring

matters from there were introduced into practice, among such being logwood, cochineal, annatto, Brazil wood, &c. Curiously enough, indigo, although known to the ancient Romans, and at the time regularly imported from India, was not re-introduced into ordinary practice in Europe until the 17th century, at the time of the journeys made by the Portuguese and the Dutch to India, although the dye must have been in actual employment in Italy before this date.

It is also curious to note that the introduction of indigo into the practice of dyeing was strenuously resisted at the beginning, especially by the planters of woad, which was at the time being used for the production of blue-dyed fabrics. The opposition was so strong, and at one time so effective, that the employment of indigo was forbidden by law in different countries, including England under the reign of Queen Elizabeth. Logwood also was under ban for some time, it being classed among the loose colours.

Great progress was achieved in the tinctorial arts during the 18th century, especially in France, from which country these industries were carried into England and elsewhere. These arts, which formerly were carried on principally in small establishments, have attained, during the course of the last 100 years, to the rank of great industries, and it was principally in France that large establishments originated. The progress achieved in mechanical, physical, and especially in chemical science, has been the principal cause of the development of dyeing and printing in Europe generally, and this country in particular.

But the greatest impetus to the development of tinctorial arts in modern times has been given by the discovery and introduction into practice of the coal tar colours, an event of such importance as to cause a complete revolution in the arts of colouring or printing fabrics, and consequently a special chapter is requisite to deal with the history of the development of coal tar colours.

HISTORY OF COAL TAR COLOURS.

CHAPTER II.

UNLIKE many other industries, the manufacture of coal tar colours has not been brought about by the practical application of understood facts, but here theory has preceded practice. The attention of chemists being first called to the study of the tar itself, several products were isolated and studied, and this led, in 1834, to the discovery, by Runge, of a basic substance in coal tar, which he called kyanol, on account of the blue reaction it gave when treated with a solution of bleaching powder. The same substance had already been discovered, in 1826, by Unverdorben, who obtained it by the destructive distillation of indigo, and named it krystaline. Fritsche, in 1840, described a substance having the same properties as krystaline, resulting from the treatment of indigo with alkalies, which he called aniline, from *indigofera anil*, the name of the indigo plant, and subsequent investigations by Hofmann proved that the three products were indentical. Runge's reaction remained until 1856 a scientific curiosity, when W. H. Perkin succeeded in producing, for the first time on a large scale, a violet colouring matter, which he obtained by treating a solution of aniline sulphate with bichromate of potash; this colouring matter was called mauve.

Perkin may be considered the pioneer in the manufacture of artificial colours, and his success called the attention of chemists to this new field of discoveries, wherein their efforts have been crowned with the most brilliant results. The appearance of mauve created quite a sensation in the dyeing and printing world, and the new colour could not be manufactured fast enough to supply all demands; now,

however, this product has been almost completely abandoned, having been superseded by brighter violet colouring matters. In 1858, or only two years after Perkin's patent, A. W. Hofmann, the distinguished German chemist, whose labours and discoveries have had so much influence on the progress of the industry of coal tar colours, discovered aniline red, now better known by the name of magenta or fuchsine. Quite independently of Hofmann, Verguin, in France, discovered the same product, and he was the first to start the manufacture of the new colour in Lyons in the works of Messrs. Renard Frères and Franc, whose patent is dated April, 1859.

The new product was obtained by the oxidation of aniline by means of perchloride of tin, the colour being extracted from the melt with boiling water, filtered, and brought into the market. The first advance was made in precipitating the colouring matter from the solution, and sending it out in paste form or as a dry powder; later on crystals were obtained, and in this form the colour is even now mostly used. Other processes were soon discovered for the manufacture of magenta, and several patents taken, among which the method with arsenic acid, which is even now mostly employed. Medlock patented the employment of arsenic acid in England, in January, 1860; while Girard and Delaire patented the same process in France, on May 26th, of the same year. Repeated attempts have been made to do away with the poisonous arsenic acid in the manufacture of magenta, and some works have succeeded in manufacturing magenta without this acid, by the so-called Coupier's process.

We owe to the classical researches of Hofmann much of our knowledge respecting magenta. In 1861, Girard, while trying the action of aniline on the salts of rosaniline (the base of magenta), discovered violet and blue colouring matters, phenyl violets, and phenyl or aniline blue, and the new products were soon introduced into practice; but as they required to be dissolved in spirit their use was rather limited, until Nicholson succeeded in 1862 in obtaining

blues soluble in water, by treating the aniline blues with sulphuric acid in order to obtain sulpho derivatives; these blues were named after the inventor "Nicholson Blues," and still bear this name.

In 1862 also, Cherpin, a foreman in M. Usebe's works, at St. Ouen, in France, discovered the first green that maintains its colour by artificial light, and therefore was called light or aldehyde green. Lauth had obtained a blue colouring matter by treating rosaniline dissolved in muriatic or sulphuric acid with aldehyde; but the blue obtained on fabrics was very fugitive. Cherpin complained to a friend that all his efforts to fix this colour on the fibres had met with no success; whereupon, the friend, who was a photographer, told him that he always fixed his prints by means of hyposulphite of soda. Cherpin accordingly tried this fixing medium, and was greatly astonished at obtaining a green colouring matter; he worked hard upon it until he perfected a process for the manufacture of this new green, which he sold to his employer for 30,000 francs. This dyestuff has now completely disappeared from the market.

Hofmann brought out in 1863 the Hofmann's violets, colouring matters obtained by treating rosaniline with methyl or aethyl iodide, and methyl alcohol in autoclaves; these violets have been superseded by the methyl or Paris violets of cheaper manufacture, and this has also been the fate of the iodine green which was obtained by Heisser in Lyons, and by Wanklyn and Paraf by treating the Hofmann's violet with iodide of methyle, the iodine green being superseded by methyl green.

Bardy made great progress in the manufacture of dimethyl aniline on a large scale; while Lauth, with his very original idea of oxidising the dimethyl aniline by means of sand and a copper salt, brought forward the methyl or Paris violets. Samples of Paris violets were shown at the Paris Exhibition of 1867.

Although it was formerly believed that the Hofmann's violets were identical with the dimethyl aniline violets,

further researches have proved that this is not the case, and in fact, according to the opinion of many dyers, the methyl are not so fast as the Hofmann's violets.

Shortly after the violets, methyl green made its appearance; it was first manufactured by the action of methyl iodide on the methyl violet, but as iodine is very expensive, methyl nitrate was tried with success; unfortunately the latter is so explosive that its use had to be abandoned after two fearful explosions had taken place, one in Paris, the other in a German works. Methyl green has lost much of its importance since the introduction of the new greens, all derivatives of dimethyl aniline. The priority of this discovery is claimed by Otto Fischer on the one hand, and Oscar Doebner on the other; the latter patented his process in 1878.

Attempts have repeatedly been made to obtain blues direct from aniline derivatives without the employment of rosaniline, and although these have not been quite successful, as in the case of the violets, products have nevertheless been obtained from diphenyl amine and methyl diphenyl amine, which have found ready acceptance for dyeing purposes. Bardy in 1869 produced blue dyes by the oxidation of the methyl diphenyl amine, but as the colour was only soluble in spirit and was of a greenish cast, it only found limited employment. M. Emile Kopp obtained in 1874 a blue colouring matter soluble in water by the action of oxalic and sulphuric acid on methyl diphenyl amine; the same process had already been discovered by Girard, but kept secret until Kopp's process was published. More recently a blue colouring matter has been obtained by the action of chloranil on methyl diphenyl amine, the process being patented in 1879, and the product is now being manufactured pretty extensively. The colour is soluble in spirit, but can also be rendered soluble in water by treatment with sulphuric acid.

Of the phenyle colouring matters, aurine (rosolic acid) was discovered in 1834 by Runge, but it was not until 1859 that a practical method was invented by Mr. Jules Persoz.

Picric acid, which was formerly manufactured from different substances, is now produced on a large scale from phenol.

Of the naphthalene colours, although several were known up to seven or eight years ago, only naphthol or Manchester yellow had been manufactured on a large scale; Magdala red had also been produced, but only in small quantities, its price being excessively high. Naphthalene is now extensively used for the manufacture of naphthol, the starting point of the naphthol scarlets; these were discovered about seven or eight years ago, having appeared for the first time at the Paris Exhibition, 1878; they are due, although indirectly, to the labours of Hofmann, in the same way as the other beautiful products known under the name of azo colours.

In 1876, Otto N. Witt discovered, at the same time, and independently from Griess and Caro, chrysoidine, an orange colouring matter, which he obtained by treating a solution of phenylendiamine hydrochlorate with a solution of the muriate or nitrate of diazobenzol, the colour being afterwards precipitated by means of common salt. A whole series of colouring matters may be obtained by substituting for aniline the homologues tolnidine, xylidine, &c., and for phenylendiamine the homologues toluendiamine, &c. Hofmann, in analysing this product, called attention to this dyestuff and to analogous reactions, the result being that experiments were undertaken in most aniline dyeworks, and many brilliant discoveries were effected. Witt himself discovered the beautiful tropeolines, which range from yellow to a red orange, while similar products were also brought out by Roussin.

This again contributed still further to attract the attention of chemists, and other remarkable discoveries have followed, among them being the scarlets, which are now produced by several different processes, and have proved very formidable rivals to cochineal, which they will ultimately supersede.

The azo colours range from yellow, orange, and scarlet, to a bluish red, but only a few have established themselves

in practice, while some of them, such as the orange and the scarlets, are produced on a very large scale. A very interesting application of the azo scarlet has been introduced into practice by Holliday, the process, which is patented, relying on the precipitation on the fibre of an azo or naphthol scarlet, the shades obtained being remarkably fast against soaping and light. The first azoic colouring matter made its appearance on the market in 1864, under the name of aniline yellow. It was manufactured by reacting with nitrous acid fumes on aniline, but was soon abandoned on account of its looseness. Bismarck brown belongs to the same class of azo colours, and has met with great favour. It was manufactured at first very largely in Manchester, then passed to a London firm, and is produced now in most of the important works in England and abroad in very large quantities.

Safranine, a very important red colouring matter, was introduced into commerce in 1868 by Perkin, and was fully investigated by Hofmann and Geiger. It is an important product, and is manufactured on a pretty large scale; its name is derived from safflower, the shades of which it imitates to a certain extent, without, however, matching completely.

The indulines are reddish-blue colours, which are produced in moderately large quantities, the water soluble being especially useful for wool and silk dyeing, on which they give fast shades. The indulines soluble in spirit only are sparingly used; they have been recommended as substitutes for indigo dyeing on cotton, but are far from matching the latter either in shade or fastness. They were introduced into commerce about 1878. It is a well-known fact that some solutions when viewed by transmitted light will appear of a certain tint, while if held in another position, or viewed by reflected light, they show quite a different colour. This is the well-known phenomenon of fluorescence, and can be observed to a marked degree in a solution of Magdala red, as also in some of the eosines, which, when viewed against the light, show a pale red

colour, while in another position it shows a beautiful greenish tint. Fluoresceine was thus named by Prof. Baeyer, of Münich (who discovered it in 1871), on account of the beautiful fluorescence it shows. In 1874 a brominated derivation of fluoresceine was placed upon the market, and was followed by an iodine, and afterwards by a chlorine derivative, both of which are manufactured from fluoresceine, the bromine compound giving a yellow shade, while the iodine product gives bluer tints. Later on other interesting allied colouring matters were brought out, such as rose bengale, phloxine, and cyanosine, by E. Noelting, in 1875. Even a yellow and scarlet have been produced belonging to this class, but have not found much employment. Methyl eosine gives pretty pinks on cotton, but is only sparingly used. It is, however, matter for regret that these interesting and beautiful colours are so fugitive before light.

Galleine and ceruleine are allied colouring matters, also discovered by Professor Baeyer, of Münich, which give fast shades on cotton both for dyeing and printing; but they are not so extensively employed as might be expected. Caro patented in 1877 a process for the manufacture of methylene blue, a colouring matter belonging to a class of dyes discovered by Lauth, and this product is manufactured in pretty large quantities, and renders very good services both to the dyer and to the printer. Ethylene blue is an analogous product which was introduced later on.

A special feature in some of the colours introduced into practice during the last few years is their useful property of being able to be fixed on wool in an acid bath; they are, in fact, acid colours. Without mentioning the oranges and azo scarlets which belong to this class, special attention is demanded by the products known as acid magenta, acid brown, acid yellow, and acid naphthalene yellow, &c. All these products are obtained by treating with sulphuric acid the old and well-known colours, as magenta, Bismarck brown, aniline, and naphthol yellow; they are, in fact, sulpho derivatives; the same is the case with acid violets and

acid greens. It is to be observed that the shades obtained with these new products are faster than those obtained with the original old colours. It is well known what a revolution the appearance of artificial alizarine has caused in the dyeing and printing industries. The discovery of this dyestuff was not the result of chance, but of scientific investigations. Graebe and Liebermann found that alizarine, the colouring matter of madder, was a derivative of anthracene; they then set to work and devised a method for producing alizarine artificially from anthracene, and in 1868 patented a process which they soon improved by substituting sulphuric acid for the expensive bromine, taking out another patent in 1869 in connection with Caro. Perkin also patented a process in the same year, and became a successful manufacturer of alizarine. This manufacture is now mostly in the hands of Germans, there being only three firms in England producing it, and one or two in France.

Other colouring matters have been obtained from alizarine, such as alizarine orange, which was discovered in 1872 by Perkin, and formed on the fibre itself by Strobel, who, by exposing alizarine prints to the action of nitrous fumes, obtained a bright and fast orange. Caro patented in 1877 a process for its manufacture. From the orange, alizarine blue has been produced, but it has not been much used on account of its high price, and because it is not absolutely solid against light. An alizarine brown is also known; but of all these products only alizarine orange has found employment, and that to a merely limited extent.

To complete the history of coal tar colours, it is necessary to mention aniline black, now one of the most important colours in printing. Unlike the other aniline colours, aniline black is not used as a ready formed colouring matter, but is only developed on the fabric itself.

John Lightfoot, of Accrington, near Manchester, was the first to invent a practical process for printing aniline black, which he patented in 1863. It consisted in the employment of a mixture of starch paste, with aniline, muriatic acid,

chloride of ammonia and perchloride of copper; but was soon abandoned on account of the colour attacking the rollers and doctors of the printing machines, and of its tendering the fibre too much.

Lauth, in 1864, effected a great advance by substituting insoluble sulphide of copper for a soluble copper salt, and the process was further modified and brought into a practical shape by Koechlin, the well-known Alsatian manufacturer, who also introduced the use of tartaric instead of muriatic acid, so that the process was made capable of being applied on the most delicate fabrics. Cordillot also contributed to the progress of aniline black printing by introducing a process which allowed the black to be developed by steaming. It relies on the use of ferro, or ferricyanide of potassium, but unfortunately it is rather expensive. Both Lauth's and Cordillot's process are even now employed, but aniline black is now printed, especially in England, mostly by means of vanadium salts, bivanadiate of ammonia being chiefly used. This is a very expensive chemical, but as one gallon of thickened colour only requires about one grain of bivanadiate of ammonia, the high price of the latter does not much affect the cost of printing. The use of vanadium was first recommended by Lightfoot himself in 1871, and a patent was obtained in the same year by Mr. Robert Pinkney for the same object.

Other metallic salts have been recommended—such as those of cerium, while recently Grawitz has patented the employment of chromium compounds, and still more recently Schmidlin's patent recommends the employment of insoluble chromates.*

Those who at first printed aniline black experienced a great deal of trouble on account of the greening of the colours, and as this defect was not only a source of trouble but of great losses to manufacturers, strenuous efforts were made to get over it, and many remedies have been suggested.

* These different methods of application of aniline black are fully illustrated in the author's work on the Printing of Cotton Fabrics.

Jeanmaire, after studying the causes of the greening, recommended in 1876 that the pieces, after the black had been developed, should be passed for about half an hour in a solution of persulphate of iron at 180° F. Other oxydizers, such as chromic acid, chlorate of alumina, &c., have been recommended, and some investigators have tried to produce an ungreenable black on the fibre at once; Cordillot's black was the first ungreenable colour obtained. Grawitz obtains an ungreenable black by means of soluble chromates, while Schmidlin uses insoluble chromates; others have tried to use an aniline which gives by itself an ungreenable black by the ordinary process, and have patented mixtures of aniline and toluidine, or aniline, and xylidine, or cumidine for this purpose. Aniline black, in printing, is now used to an enormous extent, but this is not the case in dyeing, where it has found till now only limited application.

Experiments for dyeing blacks with aniline date from Lightfoot's time. In 1865 Allard patented a process—relying on the employment of bichromate of potash and aniline salt in separate baths; the same method was employed by Paraf Javal in Alsace about the same time, but without much success. J. Persoz, in 1867, applied aniline solution and bichromate of potash, either together or alternately by means of brushes, and the green colour at first formed was changed into black by soaping. Lauth proposed, in 1873, to pass the pieces first in chloride of manganese, then in soda, and afterwards in chloride of lime, and finally to dye with aniline salt. More recently several processes have been patented for dyeing aniline black—among which may be mentioned those of Delory, Grawitz, and Gatty. The two former processes rely on the employment of bichromate of potash with aniline in a single bath, muriatic acid being used by Grawitz, and sulphuric acid by Delory. Grawitz's process is pretty extensively used for cotton dyeing, either for hanks or loose cotton, for which it does very good services. But although considerable progress has been made in the dyeing of aniline black, there is still much room for improvement, in view of the fact that aniline

is still far from having superseded logwood in the dyeing of blacks.

Within the last seven or eight years several new colouring matters have been discovered; in fact, the latest feature of these discoveries is that whole classes of colouring matters have been discovered, while formerly they were only brought out one by one. Of these new products the greens, violets, reds or blues, may in future be employed industrially. One of the most important events in the history of coal tar colour chemistry was the discovery by Prof. Baeyer of a method of producing indigotin artificially. Although the discovery has not been of such practical and commercial importance as was at the time (1880) anticipated, since the artificial product, in spite of the strenuous efforts of many chemists, cannot be produced at a price low enough to compete with natural indigo, still the discovery is there, and may yet effect a revolution in the industry, if a practical method can only be found. The artificial indigo is not brought on the market as a finished product, but in the shape of nitro phenyl propiolic acid, which produces indigotin on the fibre by a process of reduction, in which caustic soda and glucose or grape sugar was originally employed. The reduction was afterwards effected by means of xantate of soda, and this method is even now employed in some printworks, but only on a very limited scale on account of the high price of the artificial product. This is only used for special purposes, and for producing fine patterns, which on account of the small amount of colouring matter used, renders its price of secondary importance. The new processes of fixing indigo by printing with natural indigo, which have been of late successfully introduced into some printworks, have also tended to diminish the importance of Baeyer's discovery.*

* From a statement in the *Chemical News* it appears that since the introduction of the ammonia process in the manufacture of indigo in India, the yield of this colouring matter has been considerably increased, and therefore Baeyer's discovery is not likely at present to be of any practical utility, although it is of high scientific value.

Among the latest acquisitions to the already large stock of colouring matters may be mentioned auramine, a yellow dyestuff, very moderately fast against soap and light, which has up to the present not found such an extended employment as was anticipated; also Victoria blue a naphthalene derivative which would be a splendid product but that unfortunately it is not fast against light. Of the numerous discoveries made in the last few years in the well-worked field of colour chemistry, very few have been of real importance, and in fact, looking at what has been brought upon the market in the shape of new dyestuffs in the last four or five years, it will be readily seen that very few new products have established themselves in practice. Since the discovery of the azo colours, and principally of the azo scarlets, there has not been anything so striking or anything so useful discovered among the colouring matters. It must be said, however, that the methods have been greatly improved, that some new processes have been successfully tried for the manufacture of some of the older colours, and that prices have been very considerably reduced, and this especially in the case of alizarine, which is sold now at very low figures.

Among the latest acquisitions must be mentioned the dyestuffs having congo red as their prototype, such as benzo purpurine, chrysamine, &c., which are so far of interest that they can be dyed on cotton without the aid of any mordant, and in one single bath. Of these the new reds, although very fast to soap, do not stand long exposure to light well, and have not come quite up to the expectations entertained of them. On the whole it seems that the field of coal tar colours, which has been found so rich, and given rise to so many brilliant discoveries, shows now signs of exhaustion (as far as really useful products are concerned), and the hopes of those who believed that all natural organic colouring matters would be artificially produced on a large and commercial scale have up to now not been realised. The future will show whether industrial chemistry will accomplish this feat.

Before concluding, it is necessary to mention the most noteworthy of recent discoveries in the field of coal tar colour chemistry—the production of blacks by means of artificial dyestuffs, a feat which up to a few months ago might be considered as beyond the reach of colour chemists. The fact is interesting, both from a theoretical and practical point of view, and may have a very important bearing on the future industry of dyeing and the colour trade generally. That we are now able to produce good blacks on wool by means of these new dyestuffs is beyond doubt, the question being how far it will affect logwood.

GENERAL CHARACTERISTICS OF FIBRES.

CHAPTER III.

HERE will be given a short description of the properties of the textile fibres, in which cotton will only be shortly treated, more attention being given to the less-known fibrous materials. Fibres are divided into two classes—the mineral and the organic. To the first belongs asbestos, the only one in reality which has been practically employed. In the time of the Romans this material was pretty largely used on account of its power of resisting fire; it was employed in the making of sheets in which the Romans cremated their dead. The use of this material has largely increased during the last few years, and it is now largely employed for machinery purposes; as, for instance, in packing joints, principally those which have to stand a high temperature, &c.

The organic fibres, as the name implies, are derived either from the vegetable or the animal kingdom, and consequently are sub-divided into vegetable fibres and animal fibres. The first comprise cotton, flax, hemp, jute, China grass or rhea fibre, &c. The animal fibres—wool, silk, &c.

The vegetable and the animal fibres differ greatly from one another in point of chemical combination, the animal fibres, in all cases, containing nitrogen, and being therefore capable of yielding ammonia under proper conditions. The vegetable fibres do not contain nitrogen, and are formed of oxygen, hydrogen, and carbon. They also differ from one another in the way they stand the different reagents, principally the acids and alkalies; in fact, as a general rule, it may be said that while animal fibres stand diluted acids even at the boil, such is not the case with the vegetable fibres. The reverse is the case with alkalies, which, if diluted, do not

attack vegetable fibres, while they act very injuriously upon the animal fibres, especially at the boil; and in the concentrated form they even destroy the latter. Under certain conditions, for instance of great concentration, or under pressure, alkalies completely destroy the animal fibres by converting them into soluble compounds.

Another point of difference in the two classes of fibres is in the way they behave against certain dyestuffs, for instance, some of the aniline colours—such as magenta, violets, &c., which dye the animal fibres very easily, while the vegetable fibres have to be specially prepared before they are able to take up the dyes. They may also be distinguished from one another by the smell they emit when burning, but this is not a very reliable test.

The best way of distinguishing the two classes of fibres, in fact of distinguishing the different fibres from each other, is by viewing them under the microscope; this is, in fact, the only absolutely reliable method for the discrimination of the different fibres.

A method of separating the fibres from each other in mixtures, for instance of cotton or wool, is based upon the different way they stand the treatment with acids. If such a mixture of wool and cotton be treated with a solution of sulphuric acid, and dried in a hot stove, the cotton can be destroyed, and the wool remains behind if the fabric is washed. A quantitative separation of cotton, or indeed of vegetable substances, can be carried on by treatment with mineral acids, or with suitable salts; this operation is conducted on a large scale, and is called chemical burling or wool extracting.

Wool containing straw or vegetable impurities is exposed to these operations of chemical burling or extracting, for which either sulphuric or hydrochloric acid or chloride of aluminium are employed; the same is performed on mixtures of wool and cotton, in which the latter is required to be removed. These operations are conducted on a large scale in Yorkshire, and, in fact, in all industrial centres where wool is manufactured.

VEGETABLE FIBRES.

Cotton.—Cotton is the down that envelopes the seeds of different species of *Gossipium*, of the family of *Malvaceæ*. It is the most important vegetable fibre, and, as regards the amount produced, is the most important of all fibrous materials. It is grown in warm climates in many countries, but principally in the United States, India, and Egypt.

Cotton consists of cellulose ($C_6 H_{10} O_5$), with about 5 per cent. of natural impurities. The impurities consist of fatty and resinous matters, with pectine wax, &c., and are mostly removable by alkalies; also yellowish colouring matter, which is destroyed by hypochlorites (chlorine).

Bleaching effects the removal of the natural impurities and the destruction of colouring matter to form pure cellulose.

Action of Chemicals.—Cotton stands well: weak mineral acids in the cold; acetic and tartaric acids even by steaming; weak alkalies at the boil and under pressure; weak hypochlorite solutions. Does not stand: strong mineral acids, even in the cold; weak mineral acids, if heated or exposed to steaming or dry heat; oxalic acid by steaming; strong hypochlorites; is mercerised by strong caustic soda solutions; is tendered if boiled with caustic lime in contact with air, or if steamed with caustic soda with access of air.

Flax (Linen) is the fibre found on the stems of the plant *linum usitatissimus* of the order of *Linnæ*, of which there are three principal varieties. Very likely the plant is a native of Egypt, where it is even now extensively cultivated. It is an annual, and does not reach quite a yard in length. The cultivation of flax is a very important one, and is carried on in several countries, principally Russia, Italy, Holland, Belgium, the North of France, India, and very extensively in Ireland, the latter country being one of the most, if not the most, important centre of the production of linen goods. The plant is not only important on account of its fibre, but also on account of its seed

(linseed), which is extensively used in medicine, and which forms the raw material for the extraction of linseed oil, and gives rise to a very important industry. This oil, being a drying oil, is very largely employed in paints and varnishes. Like cotton, the flax fibre is also principally constituted of cellulose, but this is accompanied by a thick incrustating substance of a greyish brown colour, which is very difficult to eliminate. The fibrous part is found surrounding the wooden portion of the stems, which is also called straw, and from which of course it has to be separated.

Although efforts have been repeatedly made to employ a more reasonable method of separation of the flax fibre from the woody part or the straw, no system has yet been found so thoroughly successful as the retting process.

Retting consists in exposing the dried flax stems immersed in water to a kind of fermentation, which reacts on the incrustating substances, and then allows the fibre to be more easily separated from the straw. The retting is an operation very unhealthy for the neighbourhood, as the flax is generally immersed in ditches of stagnant water, which give off putrid emanations. When the retting is complete, the stems are removed, dried, and broken up by suitable means, in order to separate the fibre from the straw, which operation is called scutching. Many new methods have been recommended, some of which are in successful operation; one of these relies on the employment of tepid water, the other on the employment of machines to separate the fibre from the dry flax stems without undergoing any retting; but, as said before, that primitive operation is still now mostly employed.

The flax fibre is of much greater length than that of cotton; in fact, it runs almost through the whole length of the stem, and it possesses also greater strength than cotton. On account of the incrustating substances, flax is much more difficult to bleach than cotton, and as it does not stand the same treatment with bleaching powder solution, the bleaching process is therefore a more complicated operation than is the case with cotton. The flax

fibre being very easily injured by bleaching liquor, great care must be taken in the bleaching processes. When properly bleached, flax or linen is of a beautiful white and very glossy, more so indeed than cotton. Under the microscope it shows hollow cylinders provided at intervals with knots.

Quite recently improvements have been effected in the production of the flax fibre in France by the introduction of machines effecting a better separation of the fibre from the flax stems. Quite lately a process of retting has been discovered by M. Parsy, by means of which the pectine substances are rendered soluble by treatment with water under high pressure; this process, which is being tried on a large scale in France, will be described in the practical part of this work.

Hemp.—Hemp is an annual plant, *cannabis sativa*, which is much taller than flax, reaching the height of 4½ to 7½ feet. Also in this case the fibre runs through the whole length of the stem; and, as in the case of flax, the fibre is found around the stick or wood which forms the interior of the stems. Hemp fibre is very strong, but of much coarser texture than flax, and is even more difficult to bleach, as it contains more incrustating substances. Like flax it is separated by the retting and scutching processes. The cellulose is also the principal constituent of the fibre, which may be distinguished from flax by means of the microscope, under which it also shows hollow cylindrical tubes provided with knots at intervals, surrounded by hairy appendices. Hemp is principally used for rope making, and also very largely for the production of coarse fabrics in the countries where it is grown, where it is also largely spun by hand.

Jute.—This fibre has acquired a very great importance in the last 20 or 30 years, during which its production has enormously increased. It is grown very extensively in India, which is indeed the only country where it is produced on a very large scale. Its principal employment is for

bagging or sack cloth, coarse canvas, etc., and it is also largely employed in the manufacture of floor cloths, forming the ground on which the colours are applied. It is also an annual plant, of which there are two varieties, *corchorus acutangulus* and *corchorus capsularis*. It reaches in India several feet in height, in some cases as much as 10 feet. The jute fibre is also found, as in the case of flax and hemp, in the bark around the wooden stick, and indeed all these fibres might be called bark fibres.

The fibre is separated from the wood by a process similar to retting, which is in fact a rottening process. The stems are immersed in water for several days, and a fermentation speedily sets in; this process is carefully watched, the sticks being tried repeatedly to see if the fibre can be easily removed, and when this is the case it is separated. But, thus obtained, it is never very strong, as the fibre is spoilt by the process of fermentation, which is sometimes allowed to go too far.

Jute is not a very strong fibre, and is even more difficult to bleach than the other vegetable fibres, so much so that at one time it was considered impossible to bleach it.

Jute does not contain cellulose under the ordinary form; but one or more other derivatives of a cellulose to which Messrs. Cross and Bevan give the name of bastose. Cellulose belongs to the class of carbohydrates, while bastose stands between these and the aromatic compounds. For this reason jute cannot be bleached in the same way as the other vegetable fibres, as when treated with chlorine it is converted into a chlorinated compound. When treated with alkalies, bastose is decomposed into insoluble cellulose on one side, and insoluble compounds belonging to the class of tannic acid derivatives.

Jute is in a certain sense already a naturally mordanted cellulose, containing tannin, and this explains why it (jute) so readily takes up the aniline colours.

Under certain circumstances jute undergoes a complete decomposition; for instance, left to itself in large masses in a wet state, especially when exposed to the action of sea

water, jute is gradually converted into tannic acid, and an acid resembling pectic acid, and in some cases it is even converted into a friable powder. The fibre does not stand well the action of acids; it is easily attacked by mineral acids, even in the cold, and more especially by heating, when it acquires a deep brown colouration, and is at the same time partially converted into volatile compounds of disagreeable odour. These effects are sometimes perceived on jute goods which have been treated with mineral acids.

In jute dyeing the same processes as for cotton cannot be employed. Permanganate of potash would also in the case of jute give very good results for bleaching; but it is, unfortunately, far too expensive, so that the only available products are also in this case the hypochlorites. But the chloride of lime must be avoided, as it readily forms chlorine compounds with jute, while such is not the case when the sodium or magnesium hypochlorites are employed. The chlorinated compounds of jute give with lime insoluble combinations, and consequently the employment of the bleaching powder must also be avoided for this reason. A ready method of ascertaining whether jute has been acted upon and converted into chlorinated compounds is by treatment with sodium sulphite, when a magenta colouration is observed. The formation of these chlorinated compounds must be avoided as much as possible, as they become decomposed by steaming, with the liberation of hydrochloric acid, which forms a deep brown colouration, and in some cases even destroys the fibre altogether.

China Grass, Rhea or Ramie Fibre.—Up to now this fibre has not been largely employed, although it possesses very valuable properties. No doubt it will have a great future, as it is very strong, and, bleached or unbleached, is of a nice silky appearance, and could be grown at a low price. The obstacle to the extensive employment of this fibre is its high price, caused by the difficulty of separating the fibre from the stems, which, up to a few months ago, could only be successfully accomplished by hand, and was

consequently a very expensive method; but very considerable progress in the processes of separation has been made within the past few years, and there is ground for hope that the growing and the working of this fibre will greatly develop.

The fibre is found contained in the bark of the stems of plants belonging to the *Urticacae* nettle family, of which there are several varieties, two or three of spécial importance—the *Urtica nivea*, or *Boehmeria nivea*, or white nettle, with a white underleaf, and the *Urtica utilis*, or *tenacissima Boehmeria utilis*.

The plants are not as yet extensively cultivated, but they grow easily in China, where they have been cultivated for centuries for the production of the fibre employed in the manufacture of peculiar Chinese fabrics, and they can be cultivated with profit in India, Egypt, Algiers America, Italy, &c.

There are several methods of separation of the fibre from the stems. They may be treated first of all either in the dry or in the green state. In the dry state the fibre can be pretty easily separated by means of suitable machines; the only difficulty being experienced in the drying of the stems, which is all but impossible in rainy seasons, especially in India. The methods of dealing with green stems are various, some relying on the employment of machines; one on the steaming of the green stems, which allows the stripping off of the bark containing all the fibre, and this is afterwards brought into commerce and worked into fibre by a chemical process.

Much progress has been made of late, and by the methods now existing the extraction of the fibre is successfully and economically accomplished. The fibre is also mostly composed of cellulose, and can be easily bleached; but it is also very sensitive against bleaching powder liquor. It is, besides, very strong, and of a nice silky appearance.*

* In another part of this work will be found a more detailed account of the methods lately tried or recommended for the extraction of this fibre.

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ANIMAL FIBRES.

Wool.—Wool is very probably the first fibrous material utilized by man, having been employed in the production of fabrics from the remotest times.

Wool belongs to the organic substances known as epidermic products, and is composed of filaments secreted by the skin of sheep and some varieties of goats. The length of the fibre varies from 40 to 180 millimetres, and its thickness from $\frac{1}{25}$th to $\frac{1}{15}$th of a m.m., the quality varying considerably according to the species of sheep from which it has been obtained, while it also varies according to the part of the body of the sheep from which it has been shorn.

The production of wool is of great importance, and after cotton, the bulk and value of wool produced probably exceed that of any other fibre. Many countries produce it in abundance, but large quantities are exported from Australia and South America. Wool is shorn once a year from the sheep, and in this state it contains a large quantity of impurities, which are removed by washing, when a loss of 20 to 50, and, in some cases, as much as 70 per cent., takes place. The amount of wool produced by each sheep also varies considerably, 3 to 12 lbs. per head being the highest and lowest limits.

Wool is generally washed while still on the sheep, by giving the animals, in the majority of cases, a washing in a running stream. When shorn it is also subjected to washing, preferably by means of stale urine, but sometimes also by means of carbonate of soda or ammonia, silicate of soda or potash, &c., but stale urine is now preferred by some wool-washing establishments, as it leaves the wool softer than any of the other detergents. This washing of the wool is now conducted in large and special establishments, and generally by means of the wool-washing machines.

Wool differs from the vegetable fibres, especially on account of its structure and chemical composition. Under the microscope the fibre of wool shows long cylinders, with

projections in regular order, which, to a certain extent, may be compared to the scales of fishes. The peculiarities in the behaviour of wool are due to these projections, as for instance, the felting, which is due to the projections, under certain circumstances, getting out of their normal position, and running into each other in such a way that they cannot be easily separated. This property is taken advantage of in the manufacture of felt articles, such as of felt hats, and also in the fulling of woollen fabrics. In the treatment of wool, great care must be taken, since by long boiling or hot steaming, or by friction and rough treatment, it is apt to produce felting.

In chemical combination wool differs from vegetable fibres, on account of the nitrogen it contains. It also contains a fairly large quantity of sulphur, and for this reason in dyeing of bright and light shades, copper or lead vessels ought to be avoided. The pure fibre contains an organic substance called keratine, and yields from 0·3 to 0·5 per cent. of ash containing phosphate of lime and magnesia, sulphate and carbonate of lime, silica and peroxide of iron. Keratine is formed of protein substances, and contains a pretty large amount of sulphur, which can be mostly removed by means of alkalies.

The following will show the percentage of pure fibre in a commercial sample of raw merino wool, as analysed by M. Chevreul :—

Earthy matters removed by washing with water	26·06
Suint or yolk	32·74
Neutral fats	8·57
Earthy matters obtained after the removal of fats	1·40
Textile fibre	31·23
	100.00

The next analysis gives the approximate composition of a sample of washed wool.

Mineral matters	0·94
Suint	21·00
Pure wool	72·00
Moisture	6·06

Suint or yolk is a kind of saponified grease, soluble in cold water, and containing a large percentage of potash, which is sometimes recovered from the washing liquors, these being evaporated to dryness, and then ignited to burn the organic substances. The recovery of potash is not now of much importance, owing to the cheap production of potash salts from the Stassfurth Works, the product obtained being a very good quality of potash, with only a small percentage of carbonate of soda. Wool stands the reagents in the following way:—

Sulphuric acid, when diluted, has no action whatever on wool, even at the boil; when concentrated it does not act at once, but destroys the fibre in the long run. *Nitric acid*, when diluted, gives wool a yellow colour, and when concentrated, destroys it after a while. In a mixture of *nitric* and *sulphuric acid*, wool is dissolved with the formation of nitro compounds, but by the addition of water a yellow mass is precipitated. By this reaction wool can be distinguished from cotton, which, under the same circumstances, gives soluble compounds. By this treatment with nitric and sulphuric acid wool can also be separated from cotton.

Alkalies react strongly on wool, especially when concentrated. Caustic soda dissolves it readily with formation of ammonia. Wool, however, stands pretty fairly the treatment with carbonate of soda; in fact, it may be boiled with a small amount of same without sustaining any appreciable injury.

Wool has great affinity for colouring matters, principally those of the aniline series, with which it can be dyed without the aid of any mordants.

Several oxides, or, in some cases, basic salts, are precipitated on wool by boiling—thus acting as valuable mordants, as in the case of alumina, iron, chrome, &c. Wool asserts a reducing action generally, in fact it can reduce peroxydes to protoxydes.

Before spinning, wool is prepared with a certain amount of oil. For this purpose olive oil was formerly exclusively

used; later on other products have been tried, among which is commercial oleine or oleic acid, the byproduct of the stearine candle manufacture. In the further treatment of woollen yarn this fact of the oiling must be taken into account, and, of course, all grease must be removed before the yarn can be bleached or dyed.

The suint or yolk of the wool, which is washed off the wool, and is then allowed to contaminate rivers, seems to be on the point of being successfully converted into a useful product, it having been found that the suint, if converted into a sulphur compound, can afterwards be utilised in the manufacture of soap, a good commercial product being thus obtained. The lanoline or wool fat is also a product of recent introduction in commerce.*

Silk.—Silk is the most beautiful, the strongest, and at the same time the most costly fibre. It is the product of an insect, the mulberry silkworm, or *Bombyx* or *Phalaena mori*, which is of Chinese origin, and which subsists on the leaves of the mulberry tree. Silk has been used in China from very ancient times; in fact, it is calculated that the silk culture existed there at least 2,000 years before the Christian era. It was brought over to Europe in the seventh century of our era by missionaries, who brought it over first to Constantinople, from whence through Greece it spread over to Sicily, Italy, and the South of Europe.

* M. A. Buisine has conducted some interesting experiments on very large quantities of raw material, from which it appears that this so far unutilised product contains substances which will well repay its being worked up. It will also be apparent that the yolk of wool is much more complex than has been generally admitted. When raw wool is washed with water the washings contain free carbonic acid, carbonate of ammonia, carbonate of potash, besides such volatile acids as acetic, propionic, butinic, valerianic, and capronic acids, etc. Besides these were also found oleic, stearic, and cerotic acids, which are of course found in the wash waters in combination with alkalies, and are either found naturally in the wool or are formed by the reaction of the carbonate of potash on the impurities of the wool fibre. Other organic acids were also detected. M. Buisine thinks that it would pay to extract useful products out of the washings of wool; in fact, the suint of a sample of Australian wool contained in 100 parts dry substance:—7·1 acetic acid, 4 propionic, 2·6 benzoic, 2·5 lactic, and 1 caprillic acid.

There are several varieties of silk, according to the species of silkworms from which it is derived. The silk industry is a very important one, but not so important as that of wool or cotton. Unlike the other fibres, silk is very long; it is drawn from the cocoons, which are generally either yellow or white, and the fibre is coloured accordingly. In the production of silk, the silkworm has first to be reared; this is done in China and Japan, but also to a very large extent in the South of Europe, principally in Italy and France. The seed was up to a few years ago mostly imported from China, and the worms developed and reared in Italy and also in the South of France. In the last few years, however, the Italians have succeeded in becoming thoroughly independent of foreign seed by bringing the production of the indigenous sorts to great perfection, owing to the introduction of scientific methods. The worms, after having reached a certain size, begin to form their cocoons, in which they ultimately envelope themselves completely. The silk is obtained from these cocoons by softening them in hot water, which allows the thread to be drawn out. This work is done by women in special establishments, of which a large number are to be found in Italy, where the industry is the most important in Europe. The operation is called reeling; as a rule, three or more cocoons are placed in a basin with water, which is kept boiling all the time, and the threads of each of these cocoons are joined together so as to form a single thread. This is easily done by means of the gum which is found naturally in the silk, and which, being softened by means of the hot water, allows the threads to stick to each other, forming a single one. The length of the fibre extracted from the cocoons reaches sometimes 350 yards, but not all the silk can be extracted from the cocoons, as there still remains a certain amount on the body of the insect. A second quality is now obtained from the residues of the silk reeling establishments, which is "silk waste," and is made afterwards into what is known now as spun silk.

Silk is formed of an interior part called *Fibroine*, which constitutes the true fibre, while the external coating consists of a mixture of albuminoids, nitrogenous, fatty, and resinous substances, and containing also the colouring matter of the coloured silks.

The following analysis by Mulder will give an idea of the constituents of raw silk :—

	Naples yellow silk.	*White Levant.*
Fibroine	53·37	54
Gelatine	20·66	19
Albumen	24·4	25·5
Wax	1·39	1·11
Colouring matter	0·05	—
Fatty and resinous matters	0·1	0·3

Fibroine has a glossy appearance similar to that of silk itself, but not quite so strong or brilliant. Both fibroine and silk are dissolved by an ammoniacal solution of oxyde of copper, but no precipitate is obtained by the addition of salts, sugar, or gum to this solution, as is the case with cotton. Dilute acids, however, precipitate white floculent masses out of this ammoniacal copper oxyde solution.

Basic chloride of zinc at 60° Bé dissolves silk in the cold, and more readily by heating, and it forms a kind of varnish.

Sulphuric acid does not act in the cold, neither in the heat if diluted; but if concentrated it dissolves silk when heating, and gives a brown solution, which turns afterwards to red. Mixed with water no precipitate is obtained with this solution; but a precipitate is produced by the addition of tannin.

Nitric and muriatic acids dissolve silk readily at ordinary temperature. Alkalies give a precipitate with this solution.

Nitric acid alone, when diluted, gives a yellow colouration to silk, and this reaction has been utilised for obtaining a yellow colour on silk. Hot nitric acid destroys the silk with the formation of oxalic acid.

Diluted alkalies do not dissolve silk, but ought not to be employed in connection with it, as they render it less

brilliant. Ammonia and weak carbonate of potash or soda solutions do not react on silk, but concentrated caustic soda or potash dissolves it readily.

Unlike wool, silk does not contain any sulphur, but it contains nitrogen. When burnt it leaves about 0·3 per cent. of ash.

The fibroine has the property of combining with tannic acid to form regular chemical combinations in the same way as hide does in the production of leather; this property is utilised in the weighting of silk, especially black silks, which are very largely increased in weight by means of tanning materials, iron salts, &c. Silk also combines with stannic chloride to proper chemical combinations, which property allows also of the possibility of weighting either white or coloured silks.

Silk is very hygroscopic, and being such a costly material, the amount of moisture contained in the article is a question of great importance; consequently in the centres of the commerce of silk there are special establishments where the silk is officially tested for its amount of moisture—the so-called "conditioning" of silk. Samples are taken out of the bales and weighed, then weighed again after having been exposed to hot air for drying in the conditioning apparatus, and the amount of moisture is thus calculated.

Within the last few years other varieties of silk have been introduced into the industry, such as the Tussah silk of India, etc., and although not so beautiful as the others, they have still been found very useful. At first it was found difficult to dye and especially to bleach these new varieties, but these difficulties have now been overcome.

TESTING COLOURING MATTERS BY DYEING.

LABORATORY WORK.

CHAPTER IV.

With the ever increasing number of dyestuffs employed in dyeing it has become of great importance that dyers should possess a certain amount of practice in the manipulations of the laboratory, and at the same time be capable of estimating the value of the products. It has, therefore, been deemed necessary to collect here the necessary information relating to the testing of colouring matters.

It must here be observed that only the comparative methods of dyeing will be mentioned, since the purely chemical methods which may yield reliable results in the hands of the skilful chemist are not capable of general application, and are therefore very seldom used in practice. The comparative method consists in dyeing patterns with the different samples of dyeing materials against each other, and in judging of their value by the comparison of their colouring power.

But it must not be understood that the comparative method of testing by dyeing is unscientific or inexact; on the contrary, it relies on scientific principles, and on methods of exact weight and measurement. No strict and definite rule can be given for the dyeing methods which are to be employed in the testings, but it may be said that it is advisable that the methods which are used in practice should also be employed in the testings. The choice of the material also ought to depend upon circumstances, as it cannot be laid down as a strict rule that the dyeings must

be made either on wool, silk, or cotton, but I should advise every dyer to make his tests on the material for which the colouring matters are intended; for instance, it would be very undesirable that a cotton dyer should perform his tests on wool, and still more so that a wool dyer should try his colours on cotton, or a silk dyer perform his experiments with either of the other materials. A calico printer also will have more reliable results if he tests his dyestuffs by printing rather than by dyeing, and this for obvious reasons.

Wool is the most convenient material for testing dyestuffs generally, and in fact in the majority of works engaged in the manufacture of colouring matters the testings are, as a general rule, performed on wool; but this practice cannot always be followed, since some colouring matters which will work one way on wool will work quite differently on cotton, and besides, it will be found difficult to convince cotton dyers that they have to perform their trials on wool.

To the consumer it is, as a rule, quite immaterial what a dyeware contains, and also what is the percentage of pure colouring matter contained in a given sample, provided that the product answers for his purpose, both in regard to cost of production and brightness of the shades produced; and the chemist or the practical man must in this instance never lose sight of the commercial aspect of the question.

In the comparative method one sample is generally used as a standard, that is, a sample is selected which has been used before, or one of a known quality, and against this standard sample the other sample or samples of the other colouring matters are dyed or printed.

A rule which will be found useful in practice is always to take into account the price of the different products, and calculate the amounts of the materials to be used in the testings in proportion to their prices. If the prices are not known, then this plan cannot of course be followed, but in this case equal quantities are taken, or it is sought to find out by how much per cent. one sample is stronger or weaker than the other.

The apparatus used in the testings of the dyewares are of rather a simple character. Some chemists prefer glass beakers, heated in a water bath; some use earthenware vessels, also heated in a water or an oil bath; it is merely a question of personal experience and liking. The writer prefers enamelled iron dishes, simply heated on a Bunsen burner, and these answer very well if not many tests are required at once; but if several tests by dyeing are required at once, then the glass beakers or the earthenware vessels are preferable. The beakers have, however, the great drawback of easily breaking, while the glazed earthenware vessels are not open to this objection. These latter have been found very useful in the English schools of dyeing, and I have seen them in use with great advantage in a large cotton and wool dyeworks of this city. These earthenware vessels have the capacity of about one litre, and are provided with a ring at a distance of one inch from the top, by means of which they sit on the perforated lid of the water-bath, while the body of the vessel is immersed in the water. Of course graduated glasses or flasks are required for the purpose of dissolving the colouring matters, and pipettes are also necessary for measuring out the solutions of the dyestuffs, when added to the dyebath.

To describe all the methods of testing the different dyestuffs necessitates a description of the processes for fixing the different colouring matters, and therefore the reader is referred to the practical part of this work. In this chapter a general idea of the plan which may be followed will suffice. It may here be remarked that it is not such an easy matter to conduct the testings of dyewares, as is often imagined; it requires at the hands of the chemist who devotes himself to this branch of commercial chemical analysis a more extended knowledge of the different colouring matters and their mode of fixation than can be gathered from test books, and in fact there have been up to the present no test books published, either in the English or any other language, in which a student could gather information about the different methods of fixing the

colouring matters, so as to form a plan of conducting his tests in a systematic manner. There are, nevertheless, excellent books on dyeing and calico printing exceedingly useful to practical men, and even to students, which show the different methods of employment of the colouring matters.

The colouring matters may be divided into two classes—the mineral and the organic dyestuffs. The mineral colouring matters are generally formed on the fibres, such as chrome yellow and orange, manganese brown, &c., and the substances used in these cases are of so well known and definite properties that they are tested according to the ordinary methods of chemical analysis.

The organic dyestuffs are divided into natural and artificial products. I will describe first the

Artificial Organic Colouring Matters, which are found in commerce in such a profusion, and sometimes in a very high degree of purity, as being those of more easy application. Of the artificial dyestuffs used in dyeing we have the benzene, naphthalene, and anthracene derivatives; the benzene products comprise those generally known as aniline colours, beside phenol derivatives, such as picric acid, aurine, &c., and resorcine colours, such as eosine, &c. Of the naphthalene products the azo compounds are of great importance, while of the anthracene derivatives the alizarine and allied products form a most important and distinct group of colouring matters.

The aniline colours are subdivided into basic and acid products; among the basic dyestuffs may be reckoned in the first place magenta, the rosaniline blues, methyl violets, methyl and malachite green, methylene blue, induline soluble in spirit, and the blue dyestuffs derived from methyl diphenyl amine, and soluble in alcohol, beside safranine, phosphine, chrysoidine, and last, but certainly not the least in importance, Bismarck brown, or phenylendiamine brown.

The acid products are generally the sodium or ammonium salts of the sulphonic acid derivatives of some of the above

basic colouring matters, such as acid magenta, acid violets, the alkaline soluble and cotton blues, the induline soluble in water, &c. The majority of the azo colouring matters are also acid colours, and so are the eosines. The denomination of acid colours for these colouring matters is perhaps not quite correct, but this name has been given on account of the fact that all these products can be employed on wool in an acid bath.

The basic colouring matters are generally fixed on cotton, previously mordanted with sumach and tin crystals, or tannic acid and tartar emetic, and they are tested accordingly. For the material to be used in the testings, either bleached cotton yarn or cotton cloth may be used; for the yarn a medium count is used, neither too thick nor too thin, while for the calico, one is preferable which is not too closely woven. The yarn which is preferably employed is the one which can be easily divided in a known quantity. It is preferable to mordant a large quantity of cotton yarn or cloth at once, and keep it for use, rather than to have to prepare the cotton every time for each testing.

For preparing the cotton the following plan may be adopted: 100grs. of bleached cotton yarn are worked for 20 to 30 minutes in a bath prepared with 3 to 5grs. of tannic acid in 1 litre of water, at about 70° C, then immersed in the liquor and left overnight. Next morning the cotton is lifted out of the bath, wrung, and passed into a new bath prepared with 2grs. of tin crystals (stannous chloride) in 1½ to 2 litres of cold water. The yarn is worked in this bath for 20 to 30 minutes; it is then washed and is ready for the dyeing tests, or it may be dried and kept for use.

For cloth the same plan of the mordant can be followed, and the dried cloth may afterwards be cut into bits of about 3 to 4 inches by 6 or 8 inches, or weighed in pieces of 4 or 5grs. each and kept ready for use.

For the solution of the samples of dyestuffs any measured vessel may be used, either a glass beaker or flask, or even an earthenware or porcelain vessel of known capacity; a half litre flask, or one measured to hold 200 cubic centimetres,

will be found useful. One gramme of the product is generally weighed and put into the flask or beaker, and then boiling water is poured on the same in small portions at a time by well shaking the flask, or if it is in a beaker by agitating well with a glass rod, then more water is added until the ½ litre mark is reached. For the dyeing, the solution of the dyestuff is measured out of the pipette and added into the dye vessels previously filled with cold water. The cotton is always immersed while thoroughly wet; that is if it has been mordanted and kept ready for use, it must be thoroughly wetted with cold water before adding to the dyebath.

The dyeing is started cold, and then it is heated gradually up to the boil, the material being constantly agitated with a glass rod. When the dyeing is finished, if no excess of dyestuff has been used (which ought never to be the case, since only enough solution of the colouring matter ought to be added to saturate the mordant), then the bath is perfectly clear, or at all events will become perfectly clear when the dyebaths have stood for a little while before the swatches are washed. The amount of colouring matter to be used varies according to the products employed, but about one per cent. of the majority of aniline colours will be found sufficient to obtain a full shade, and in the case of magenta and methyl violets, even ½ per cent. of colouring matter to the weight of the material will give a medium shade. By this method, with tannic acid and tin can be tested magenta, aniline blues soluble in spirit, methyl violets, methyl and malachite greens, auramine yellow, methylene blue, the Victoria blues, safranine, phosphine, chrysoidine, and Bismarck brown.

With the tannic acid method can also be tested the so-called cotton blues, derivatives of phenylated rosanilines; these are of an acid character, and are in fact the sodium, potassium, or ammonia salts of the sulphonic acid compounds of threephenyl rosaniline. These cotton blues, which are met in commerce of different shades, from reddish to greenish blue, can be tested on cotton mordanted with

sumach or tannic acid and tin by adding the colouring matter and 5 to 10 per cent. of alum into the dyebath, which is brought up to the boil and kept boiling for about 20 or 30 minutes, left to cool in the bath, and then slightly washed and dried.

The following method of mordanting cotton will be found very useful, as by its means almost all the acid colouring matters can be fixed, and also some of the dyewoods. The cotton is mordanted with a 10 per cent. solution of alizarine oil, wrung and dried in the stove; then it is mordanted again with acetate of alumina at about 10° Tw.; wrung and dried again in the stove, left to air for a day or two, and kept ready for use; when it is required the material is cut or divided into swatches of about 5 grs., and well wetted with cold water. The dyestuff is dissolved in the usual way, and added to the dyebath, which is gradually heated up to the boil; then the material is allowed to cool in the bath, and is slightly rinsed and dried.

The dyestuffs that can be fixed by this means are the aniline blues for cotton, the azo dyestuffs, from yellowish orange to red orange, yellowish reds and scarlets; also acid naphthol yellow, the eosines, &c.

Alizarine can also be tested on cotton so mordanted, only in this case the material before being dyed is passed into a warm bath at about 150° F., with 10 per cent. whiting (chalk) to the weight of the cotton; it is then washed and dyed in a new bath with the colouring matter by the ordinary alizarine dyeing process, after which may follow the oiling and steaming and soaping.

Alizarine is very often tested in printworks on calico which has been previously printed with stripes of thickened mordants, such as acetate of alumina, acetate of iron, and a mixture of both, and after ageing and dunging, weighed or measured quantities of the calico are dyed with the different samples of alizarine to be tested. As this is an old method well known to every calico printer's chemist ever since madder was used, it need not be described. All the acid colours can be tested with the greatest ease on wool, which

is also a very convenient material for the basic colouring matters derived from coal tar.

The methods of dyeing wool with coal tar colours, such as magenta, violets, &c., are so well known that it would be useless to mention them, and as for the acid dyestuffs the majority of them can be tested by dyeing the wool in a bath acidulated with acetic, or, in the majority of cases, sulphuric acid; two to five per cent. of the latter acid added to the dyebath is quite sufficient, and in some cases an addition of Glauber salt, five to ten per cent., is deemed advisable. The dyeings are generally started cold, and in many cases the colour is completely fixed before reaching the boiling point, but in some instances, as, for example, in the case of scarlets a boiling is necessary, and especially in the case of soluble blues and indulines, a protracted boiling will be found indispensable.

Of this class of acid colouring matters we must make an exception in the case of the alkaline blues, which cannot be properly tested on wool in an acid bath, but have to be tried in an alkaline bath, as they are used in practice, for the following reason. When manufacturing the aniline blues with sulphuric acid, in order to render them soluble in water, according to the quantity of sulphuric acid employed, and the temperature and duration of the operation, three special classes of products are obtained of very distinct properties, viz., the alkaline blues, sodium salt of mono sulphonic acid of triphenyl rosaniline; the soluble blues, generally salts of the disulpho products; and the three and tetra sulphonic acid derivatives which form the so-called cotton blues. The alkaline blues are generally used for wool and silk dyeing in a bath made alkaline with soda crystals or borax, and the blue is afterwards developed in a new bath acidulated with sulphuric acid. The disulphonic acid products, which are principally used for dyeing silk in an acid bath, would not work at all in an alkaline bath, and this would also be the case with the so-called cotton blues, which would never be fixed on wool by dyeing in an alkaline bath. Then, again in the case of the cotton blues,

these are soluble in water, and even soluble in weak acid solutions, and are not precipitated out of the dyebaths by the addition of alum, and for this reason can be used in cotton dyeing, and are sometimes dyed on cotton which has had no preparation in a bath containing the dyestuff and alum.

Therefore, especially in the case of the aniline blues soluble in water, the testings must be made on the materials for which they are employed in practice, and by the same methods of fixation as are used in the works, since the three different classes of products work quite differently on the different materials.

For the NATURAL ORGANIC DYESTUFFS I also recommend that the same method of fixation of these products be employed in the testings, and the latter ought to be done on the materials on which they are used in the works, and this in spite of the fact that with some of the colouring matters the dyebath is not exhausted in the first dyeing; but this is a difficulty that can be easily overcome by dyeing several swatches in the same dyebath, and adding less colouring matter for the following dyeings than for the first.

A method of general application for estimating the colouring power of some of the dyewood extracts, and even of tannic acid and tanning materials generally, consists in preparing cotton cloth in a bath of iron acetate, then drying and exposing to air for a day or two, and the material is cut into weighed or measured quantities, and kept in stock for use.

When performing the tests, the bits of cloth are either well wetted, and then introduced into the respective dyebaths, or, better still, they are passed into a chalk or whiting bath first, then well rinsed and dyed with the samples of dyewood extracts to be tested. With this method, logwood, chestnut extract, as well as sumach and its extracts, tannic acid, &c., can be tested by comparison with a standard sample; greys or blacks will be formed on the fibre, and the relative strength may be judged by comparing

the shades obtained with each. On this mordant could be also tested the majority of the other dyewoods, but this is not advisable, since fustic or quercitron, or any of the red woods, are seldom dyed on iron mordants. Consequently for the remaining natural colouring matters, the ordinary methods of fixation should be employed in the trials for the commercial value of colouring matters: for instance, in the case of barwood the well known methods of fixation on sumach and tin had better be followed, and for quercitron, or its extract of its purer derivative, flavine, the well known methods of the formation of the fine yellows on cotton must also be followed. Catechu cannot be tested by any other method than by dyeing catechu brown by means of bichromate of potash, since any method for the estimation of the catechu tannin will be unreliable on account of the organic impurities which are always to be found in commercial samples of catechu, and indeed of the majority of the extracts of natural dyestuffs.

No colouring matter has been so much discussed as INDIGO, and in no other case have so many methods been recommended as for the estimation of indigotine, and very many chemical methods are published in the test books. I do not propose to discuss the best chemical methods now in use for the quantitative analysis of indigotine, for which I beg to refer the reader to the remarks on the subject contained in my first volume on Printing. I state it again as my opinion on the general applications of the chemical methods for indigo testings that they are no doubt very valuable, but that they are all more or less open to the objection that in some cases they may not yield true results. They are quite correct when the samples are of medium purity, but if they are very poor in colouring matter, then the results will be very greatly influenced by the organic impurities; and therefore, in the case of indigo testing especially, I am not able, even now, to change an opinion formed several years ago—that the dyeing tests are the only reliable ones. It must be admitted

that the dyeing tests also offer many difficulties, and that they may cause errors if not carefully performed, but still in all cases they furnish us with direct results, and can also be performed with quickness.

The reduction of indigo by the Schützenberger and de Lalande's process gives the readiest means of forming a dyevat on a small scale, in which the colouring power of indigoes can be estimated. The samples of indigoes are first well ground dry in a mortar, then mixed with water, and ground again very finely; zinc dust is then added, and also the bisulphite of soda, the whole being well stirred by means of the pestle, and finally a certain quantity of caustic soda solution is added, and the whole well agitated. The indigo will be reduced at once, and can be added to a bath of cold water to form a miniature vat, where the cotton can be dyed in a few minutes. As I have it now, this method will give good results, and not more than half an hour will be required to perform two or more tests of indigo samples by it. The latter are weighed out in proportion to their prices, so in this case the colouring power will at once be commercially estimated. For this test the following proportions may be employed: 1 gr. indigo, 2 to 3 grs zinc dust, 10 cc. bisulphite solution; stir, then add 2 grs. caustic soda powder 98 %. After reduction make up to 1 litre with water, and dye in this vat with 30 to 50 grs. cotton yarn at the time.

To average chemists the methods of estimation of the dyestuffs by simple dyeing operations may perhaps not appear a scientific system to follow, but those who look a little closer into the matter will soon perceive that the methods by dyeing are really scientific, since they rely on exact methods of measurement or weighing, and in fact when we perform a dyeing operation we simply go through the chemical process of precipitation of the colouring matter on the weighed material, and thus have definite data of the amount of the dyeing product employed, and of the material on which it had been precipitated. We might without any difficulty again weigh the dyed material, and find out the

actual quantity precipitated on the fibre, thus performing a simple operation of quantitative analysis, but this is seldom done in practice, since we judge by the eye of the amount of dyestuffs thrown down on a fibrous material by comparison with another of known quality.

PRACTICAL PROCESSES.

CHAPTER V.

BLEACHING COTTON.

BEFORE SPINNING, LOOSE COTTON.

Cotton is seldom bleached in the loose state, as it is not often required in this form, except in the manufacture of waddings and for other similar purposes, as for lint, &c The chemical process is simple, since it seems that cotton before spinning is more easily bleached than after it has undergone the spinning process; at all events, so it has appeared to be in the hands of the author in some experiments made in the laboratory. By following the same process on both loose and spun cotton at the same time, a better white was always obtained on the unspun material, and this may perhaps be accounted for by admitting that cotton takes up in contact with machinery or the hands of the operatives a certain amount of grease, which, by forming a very thin film, prevents to a certain extent the action of the chemicals, especially if these be applied in the cold, as was the case in the experiments referred to. The process employed was as follows:—

1st.—Prepare solution of sodium hypochlorite by dissolving 50 to 100 grs. bleaching powder in 1 litre cold water. Leave to settle, decant or filter, then add a strong solution of carbonate of soda until no more precipitation of carbonate of lime takes place, which is easily ascertained by filtering a small quantity through a paper filter, and then adding more of the carbonate of soda solution to see whether a precipitation takes place. A slight excess of carbonate of

soda will be rather beneficial, and seems to help in the bleaching process. This hypochlorite solution is made up to 4° Tw., and can be kept in bottles for use.

For the Bleaching Process.—Immerse the cotton just as it is taken out from the bale in a bath prepared with the sodium hypochlorite solution, showing from 2° to 4° Tw. Work it in this bath until thoroughly impregnated, and leave to rest for three or four hours, or even overnight, then take out, leave to drain, and wash.

2nd.—Place in bath with weak bisulphite of soda solution showing about 2° to 3° Tw. (or a weak sulphurous acid solution will do as well), work for one hour, or until thoroughly penetrated, and wash. If the cotton is not perfectly white, the operations may be repeated. If necessary the material may be blued or softened in the usual way in the cold. The cotton so bleached is not at all tendered.

A weak sulphuric or hydrochloric acid bath might be employed instead of the bisulphite solution, but it must be observed that loose cotton is difficult to wash, and that any trace of mineral acid left behind will react on the cotton, and tender it when the material is being dried. Therefore if any mineral acid be used the cotton must either be repeatedly washed to remove all trace of acid, or it must be passed through a weak bath of bisulphite of soda, which has the further advantage of neutralising the injurious effect of any excess of chlorine left on the fibre after the bleaching operation. By the employment of weak bisulphite solutions washing with water may also be dispensed with, and the operations rendered shorter and simpler.

Such good results were obtained in these experiments that the idea was entertained of seeing whether it would not be of more advantage to bleach the cotton in the loose state before spinning rather than to do it after weaving, as is now done for printing and market bleaching. It is true that the cotton becomes to a certain extent soiled through the operations of spinning and weaving, but this would not stand in the way, since a scouring, and, if necessary, a very slight bleach would make the cloth perfectly clean and

white again. The idea was, however, not acted upon, as no opportunity was offered for trying the process on a large scale. It may, however, be worth a trial by those who are favourably situated.

The ordinary process of bleaching, such as the one followed for yarn, and described later on, cannot very well be followed, owing to the state of the material. First of all a boiling under pressure (unless done in a kier with a large number of diaphragms to divide the mass of material into several lots) does not give good results, because the loose cotton is apt to clot together, and some of the cotton will remain untouched, as the liquor cannot penetrate throughout the mass. In the ordinary apparatus also it will be found difficult to treat large masses of loose cotton at one time, owing to the same drawback of the liquors not penetrating throughout the mass.

For this reason, in the processes ordinarily followed, the boiling is in many cases dispensed with altogether, and the bleaching effected in tubs or vats on small quantities at a time by treatments with bleaching liquor, and followed by washing and acid solutions, the operations being repeated until the desired white is produced.

In the author's experiments with the sodium hypochlorite solution, which was rather alkaline owing to a slight excess of carbonate of soda, the cotton was very readily penetrated throughout the mass, the white produced was good, the fibre as strong as before, and according to the opinion of friends engaged in cotton spinning, it would not offer any difficulty in the *spinning process*.

BLEACHING OF COTTON YARN (IN THE LABORATORY).

1st.—Scour the yarn with 3 to 5 per cent. soda ash, or 2 to 3 per cent. caustic soda. Boil for one to two hours and wash.

2nd.—Prepare a bleaching powder solution of 1° Tw., proceeding in two ways—(*a*) With the bleaching powder.

Weigh 10 grs. of bleaching powder, or chloride of lime, and put in a mortar with just enough water to make a thin paste, grind the whole with a pestle, then leave to settle a few minutes, and filter the liquor through a calico or paper filter; to the residue in the mortar add more water, grind again, and filter the liquor, and treat the residue again with water until the whole of it has been brought on the filter. Collect all the filtered liquors, and make up to 1° Tw. by means of cold water. (*b*) Take the commercial bleaching liquor and make it up to 1° Tw. with cold water, using a large earthenware jar of 1 litre for the purpose.

3rd.—Enter the yarn in this bleaching solution, and work it for 1 to 2 hours occasionally, or until the cotton is quite white; take out of bath and wash.

4th.—Make up a new bath with sulphuric or muriatic acid of 1° Tw. in an earthenware jar, or any other suitable vessel to hold 1 or 2 litres. Work for 1 or 1½ hours in this acid bath, then wash *well*.

5th.—Prepare a soap bath with 5 grs. of soap in boiling water; boil cotton in this bath for 1 hour, then wash and dry. The result will be a cream white, but if a blue white is wanted, then some blue must be added to the soap bath. This is done in the following way: dissolve ½ gr. of alkaline blue 3 B in 100 cc. of boiling water, then make up to 1 litre with hot water. Add of this solution 1 or 2ccs. or as much as will be required to give a blueish tinge to the soap bath. Work cotton in this soap blueing bath for 1 hour, then wash and dry.

N.B.—If the cotton is not blue enough, more alkaline blue solution may be added to the soap bath. In some cases ultramarine blue is used instead of alkaline blue. Methylene blue is also preferred by others, while in some instances even a greenish hue is required, which is produced by means of methyl green, blue shade; but ultramarine is the blueing agent mostly employed on the large scale, and is employed along with the soap after bleaching.

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BLEACHING OF COTTON YARN.

The process generally followed consists—1st, in the *scouring* or *boiling*, by means of alkalies, for which, as a rule, soda ash or caustic soda is employed. Of soda ash about 3 to 5 per cent. is used, while in the case of caustic soda the amount employed averages about 2 to 3 per cent. to the weight of the cotton. This operation is generally performed in the closed iron vessels called *kiers*, which work by steam, and are constructed to stand pressure, and as a rule are supplied with an arrangement for creating a circulation in the apparatus. Sometimes also open kiers or boilers are employed for the scouring process, but when working with closed kiers the scouring is found to be more effective.

The same treatment is employed for those yarns which have not to be bleached, but to be dyed, and in some cases, especially for dark colours and common work, the soda ash is completely omitted, and the yarns are simply boiled by means of water for the purpose of thoroughly wetting them. The pressure employed in the scouring process varies considerably in the works; in some cases only a few pounds pressure is allowed, in others the pressure is allowed to go over 20 and even 30 or 35lbs. or more per square inch.

The duration of the boiling varies also in the different works, but as a rule the operation is so performed that the kier is charged with the yarn and the necessary amount of alkaline solution, and made to go up to the pressure required; then the steam is stopped, and the pressure allowed to go down during the night of itself. Sometimes a second and short boiling with water alone is resorted to. Then follows a thorough washing, which is sometimes performed in the kier without removing the yarn, or is performed on the washing machine, or even by hand.

2nd.—the *bleaching* or *chemicking* process by means of bleaching liquor. For this purpose bleaching powder or choloride of lime liquor of about 1 to 2° Tw. is employed, in which the yarn is worked for about two hours. When the

amount of yarn to be bleached is small, the chemicking can be performed in an ordinary dyebeck, by putting the yarn on sticks and working it in the same way as in dyeing; but when large quantities of yarns are to be bleached, then other methods must be employed. As a rule, the yarn is allowed to remain stationary, and the liquor is made to react on the same, and allowed to circulate through the mass of the cotton by different mechanical arrangements.

One of these methods consists in the employment of stone cisterns or tanks supplied with false bottoms, and in which the yarn is placed after scouring and washing. The bleaching liquor is then poured on the yarn through a zinc grating placed at the top of the cistern; through a hole at the bottom of the tank the liquor, after permeating through the cotton, is allowed to run into a cistern constructed below the tank, and out of which it is again pumped and made again to descend on the yarn through the zinc grating, so that it is in a certain sense a circulation which is kept up all the time to help the bleaching process.

After the bleaching liquor has reacted for the necessary length of time, it is made to run off through the hole at the bottom in the cistern below, and the yarn is exposed to a washing with cold water, either without removing, or on the washing machines, and then *soured* by means of sulphuric or hydrochloric acid of about 1° Tw. This operation is performed either in the same tank or cistern, or in a bystanding one, in which the yarn is placed if it has been removed for washing after being chemicked.

The acid is made to react in the same way, that is, it is pumped out of the acid cistern below the tank, and made to descend through a wooden grating, which has been supplied at the top of the cistern, and thus permeates the yarn. The acid liquor is made to react for about ½ to 1 hour by keeping up a circulation in the same way as described in connection with the bleaching solution; the liquor is then run off into the acid cistern below, and the yarn is removed and well washed.

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In many cases the yarn, after being well washed, is dried, and thus a cream white is obtained, which has, however, a yellowish tinge. But if a blueish white be required, then the yarn is passed through a bath containing either ultramarine in suspension or a solution of an aniline blue As a rule, however, this *blueing* operation is connected with the soaping of the yarns after they have been bleached and well washed. In this case the yarn is worked into a soap bath containing the blue, either ultramarine or a small amount of a solution of an aniline blue, principally alkaline blue of about 3 B shade, and well manipulated by hand or by machine until the colours are evenly taken up by the yarn; afterwards it is washed, wrung, or better passed through the hydro-extractor, to remove the excess of water, and then dried.

Many systems have been recommended for creating the circulation during the bleaching operations, some even relying upon the employment of closed vessels, in which the liquids are applied by means of force pumps, and thus allowed to permeate the cotton by pressure.

One system works exactly on the opposite principle, that is by means of the vacuum (Mason's) process. A closed vessel or kier is employed, which is internally lined with lead, in order to be able to stand both the acid and the chlorine liquors. By means of a pump the vacuum is produced in the interior of the apparatus, and by opening the corresponding taps either the bleaching liquor or the acid, which in this case is always sulphuric acid, is sucked from the corresponding cisterns constructed below the kiers and allowed to react on the cotton.

By running off the liquor again, creating the vacuum and sucking up the liquor again from the cistern, a kind of circulation is also created, and thus the bleaching is very effectually performed. The yarn is first treated in this vacuum kier with the chemick two or three times according to requirements; then the bleaching liquor is run off, and the hanks washed in the kier, and without removing them; then exposed to the souring in the same vessel, washed and

washed again thoroughly on the machine, being finally blued while soaping, washed, and dried.

By this vacuum system large quantities of yarns are bleached at the same time. One iron kier is employed for the boiling, in which the yarn is also washed, and the other kier, which is lined inside with lead, serves for the bleaching. This system is especially useful in saving labour. The bleaching liquor in this case is made to stand at about $\frac{1}{2}$ to 1° or $1\frac{1}{2}$ Tw., is used over and over again, and is now and again strengthened by means of strong bleaching solution. The same is done with the sulphuric which is kept in the cistern.

This process I have seen very successfully at work for the bleaching of yarns at Messrs. Barlow and Jones's in Bolton, whilst at the School of Dyeing I have also had, by the kind permission of Mr. Mason, the use of a model of his bleaching and boiling kier, and can therefore confidently speak of this method of cotton yarn bleaching, which is one of the simplest that could be followed.

BLEACHING COTTON CLOTH, AND NEW BLEACHING PROCESSES.

Bleaching Cotton Cloth.—The bleaching of cotton in the form of cloth has been pretty minutely described in the author's "Printing of Cotton Fabrics," and therefore need not be repeated here. Bleached goods, which are very largely produced, are always afterwards passed through a finishing process, in order to make them ready for the market, and mention of the processes will be made in the chapter relating to the finishing operations.

New Bleaching Processes.—Respecting the new processes recommended, rather contradictory accounts are given of the electrical bleaching method known as the *Hermite process*. While on one side very promising reports on the cost of this method are put forward by some authorities, and good accounts are also recorded of the production of the bleaching liquors, these statements are

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denied by others. Although believing in the future of electricity as a bleaching medium, I cannot at present say that I consider the method to be as yet out of the experimental stage. So long as it is not employed on the large manufacturing scale, there is time to await the results before passing a decided opinion.

Hertel's Method.—Hertel, in a communication to the *Faerberei Muster Zeitung,* publishes some results of very interesting experiments made by him in bleaching cotton yarn by means of hypochlorous acid gas. He decomposes the bleaching liquor or powder by means of weak sulphuric acid, and allows the gas evolved to react on the cotton yarn, which has been previously scoured and washed, and is placed while still wet in a closed vessel. The bleaching is stated to proceed very quickly and very effectively with a much less quantity of bleaching powder, and to be perfect in every respect. In this case also the method is only in the experimental stage, and having been tried only on a comparatively small scale, we must wait for further trials. The vacuum bleaching kiers would be well adapted for this process on the large scale, but the penetrating of the gas throughout may be found difficult of accomplishment.

COTTON DYEING.

Although it may be said that the methods of producing colours on cotton are the same either for unspun material, yarn, or cloth, and that only the mechanical arrangements are different, still there are some methods that are preferably employed for the one which are not followed for the other, and consequently these methods will be discussed here separately.

The Dyeing of Loose or Unspun Cotton.—For the production of cotton goods this fibre is seldom if at all dyed before spinning, since the methods of yarn or cloth dyeing are so convenient, and the results so good that no necessity is found for the more complicated process of dyeing cotton in the unspun state. But if the cotton has to be mixed

with wool, and spun with this latter for production of mixed goods, then it is dyed in the loose state, the process being conducted on a large scale, especially in Yorkshire. The reason of dyeing cotton before spinning will be apparent when it is considered that the dyed material, by passing through the mixing process previous to its being made into yarn, gives a product which will appear of a very even colour.

Few colours are dyed on a very large scale on loose cotton, and they are chiefly those that are fast against light, and principally against soaping, and which have afterwards to stand the fulling or milling process, such for instance as aniline black, indigo blues, &c. Logwood blacks are also largely dyed, and so are also browns and many fancy shades.

Several arrangements are employed for the dyeing of loose cotton, differing from each other according to the quantity to be dyed. For a small quantity either copper boilers or wooden tubs are employed, the latter heated by free steam and supplied with double bottoms. For large quantities either round iron vats or square cisterns are used, generally provided with false bottoms, on which the material can be laid. In order to create a circulation of the liquors through the mass, several contrivances are employed. For small quantities, wicker baskets are sometimes used, in which the cotton is placed, and the basket is gently moved about. For larger quantities the material is either worked by means of wooden poles or by specially devised mechanical arrangements, such as by means of the vacuum or other systems—Obermeyer's, Smithson's, and others—which will be mentioned when treating of loose wool dyeing, the latter being of more importance. The machinery for the washing and drying of loose wool will be illustrated; this machinery can also be employed for loose cotton.

The vacuum apparatus, such as is used for the bleaching of yarn, has been successfully employed for the dyeing of loose cotton, and some colours, such as logwood blacks, &c., have been successfully produced on the large scale

The colours generally produced on loose cotton are the following, for which only short indications will here be given, if the processes are described in another part of the work on cotton yarn.

Blacks.

Large quantities of loose cotton are dyed with aniline black, owing to the great fastness of this colour. The dyeing process does not offer anything special over the one generally employed for the yarn, and is principally performed in the cold in large square vats or oblong cisterns.

Logwood Black—No. 1.

Cotton wool 100lbs.

1st.—Prepare boiling bath with

25lbs. logwood extract.
2½lbs. bark extract.
6½lbs. sulphate of copper.

Enter cotton, boil 1½ hour, leave in bath over night, lift out, drain, and leave in heap for 48 hours.

2nd.—Enter in cold bath previously prepared with

16lbs. copperas.
4lbs. chalk.

Work two hours, leave in heap over night or longer, then rinse and dry. This black will stand milling.

Black—No. 2.

Sometimes a black is produced on loose cotton by impregnating the same with a mixture of logwood liquor, to which the necessary amount of acetate of iron has been added, and some bark or fustic, if a jet black be wanted. After the cotton is thoroughly impregnated, it is left to air for some time and then steamed.

The steam black of the calico printers (the special preparations sold under this name) could also be employed

for the purpose, and after the cotton is impregnated with the mixture of the preparations, containing of course the mordant and drying, the black can be developed by steaming, and a very good black can thus be produced. Other colours could be obtained in the same way, such as dark blues or greys, olives, &c., by diluting the original black colour, or by adding the necessary amount of bark liquor and acetate of chromium. This method, however, is not often followed on account of its requiring steaming for the development of the colours.

Indigo blues are largely dyed on loose cotton, and the preparation of the vats does not offer anything different from those employed for yarn. Other colours do not call for special remarks here.

YARN DYEING.

This is a very important branch of the tinctorial arts, and represents of itself a very important industry. Previously to dyeing, the cotton yarn must be wetted, or better, scoured; first of all with the object of cleansing the same from impurities, but principally also with the object of wetting the material all through in order that it may be then penetrated by the dyeing or mordanting liquor, otherwise uneven shades would result. For common work the dyers do not scour their yarn, but simply boil it with water in an open wooden tub or cistern with direct steam; but for finer work the yarn is either boiled in the kier with water only, or is properly scoured with soda ash, or better, caustic soda.

The scouring is performed in the kier by taking

2 to 5 per cent. soda ash.

or

1 to 3 per cent. caustic soda,

and is followed by a thorough wash. In order to prevent the yarn from becoming entangled before being put into the kier, it is either bound up with strings, or the hanks are chained to one another two by two, or are bound together

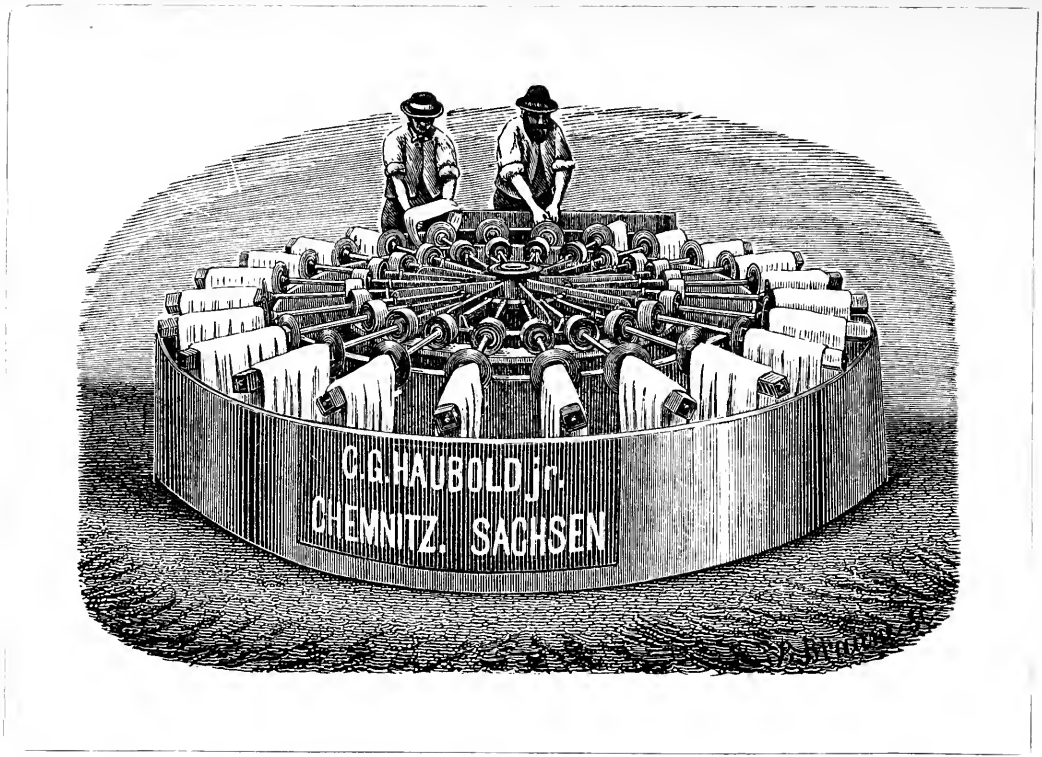

PLATE V.—CIRCULAR YARN WASHING MACHINE.

by string to form a long rope. The duration of the scouring is about one hour. After a thorough wash the scoured yarn is ready for dyeing.

Cotton yarn is either dyed in the form of hank or in a continuous manner in the form of warps, and the mechanical arrangements necessarily differ.

Only the methods of producing the colours on the fibre will be here described, while the machinery will be mentioned and illustrated later on.

Yarn is dyed a great variety of colours, which may be classified as follows:—

1.—Fancy colours, principally with coal tar dyes and dyewood extract shades.

Mineral colours—

2.—Indigo blues.

3.—Blacks.

4.—Turkey red yarns.

1. Fancy Shades.—There is now the possibility of producing no end of these shades.

Shades produced with Coal Tar Colours.—The coal tar colours are applied on cotton by distinct classes of methods according as they are *basic* or *acid* colours.

Basic Dyestuffs.—To this class belong those colouring matters which are neutral salts of (principally) hydrochloric acid, with the colouring base, such as magenta, the violets, &c. They are all fixed by the same method, viz., on mordant of tannic acid or sumach, followed by the fixing bath, either tin or antimony.

Methods of Mordanting Cotton for Basic Aniline Dyestuffs.—The principal methods of mordanting cotton are as follows:—

1st.—With tannic acid, or the corresponding sumach infusion or extract, and the fixation of the tannin on the fibre by either stannous chloride, stannic acid, antimony mordants, and seldom iron salts.

The first operation of mordanting with tannin is performed in a hot bath, prepared with either 4 to 5 per cent. commercial tannic acid, or the infusion of 20 per cent. of a

good quality of sumach (preferably Sicily sumach). For light and bright shades, tannic acid, although more expensive, is certainly to be preferred, and in this case the temperature of the bath had better not be over 70° C. The duration depends upon the intensity of shade required; some dyers leave in bath over night, deeper shades being the result; but for very light colours 40 to 60 minutes' working is sufficient. After the cotton is mordanted with tannin the yarn is lifted out of the bath and wrung (some dyers prefer to press it instead).

The second or fixing bath is prepared either with 2 to 3 per cent. of stannous chloride (tin crystals), or same amount of antimony mordant, either the emetic, double oxalate, or neutral oxalate (as lately recommended), or even oxymuriate of antimony, for which the reader is referred to the chapter dealing with antimony mordants in the author's previous work on the "Printing of Cotton Fabrics." This second bath is generally given cold, and the duration is 30 to 45 minutes for yarn. After this the cotton is thoroughly washed. Some dyers afterwards give a hot (but not boiling) soap bath, which not only removes the excess of mordant not fixed on the fibre, but gives a softness and brightness to the yarn and colour which is very pleasing.

The fixing of tannin on cotton with stannate of soda, followed by a sulphuric acid bath, is now not often followed, and there is no reason to employ this more complicated method when there are other means of simple and effective fixation with antimony mordants.

The fixation of tannin with iron salts for aniline colours is seldom resorted to unless dark shades are required of colours to which the slate coloured bottom of the tannate of iron is no detriment, such as, for instance, in the dyeing of imitation indigo blues for yarn or cloth with methylene blue. Either copperas, or preferably acetate of iron, is employed for the second fixing baths, which are sometimes also followed by a chalk bath and a thorough wash.

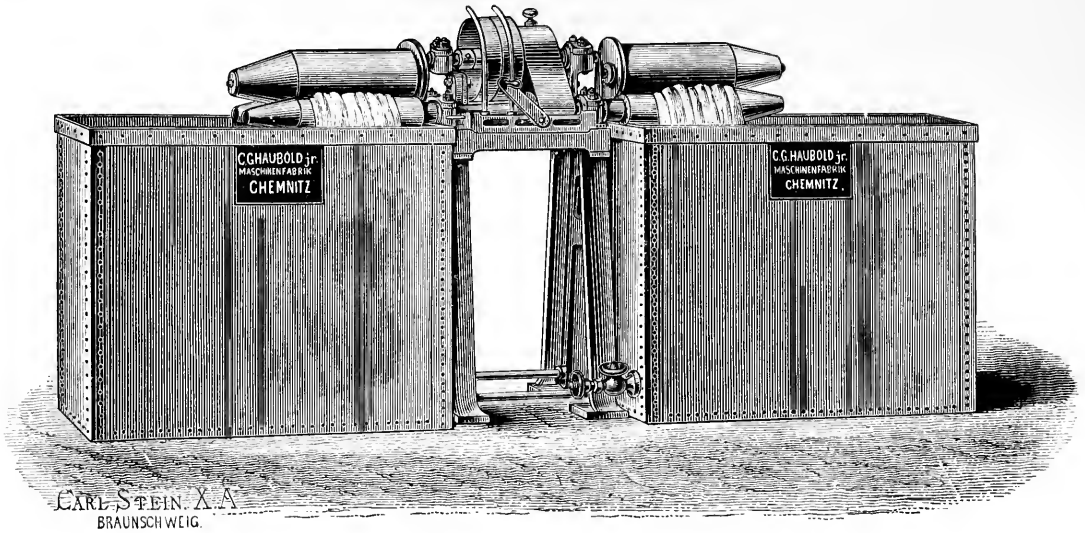

PLATE VI.—YARN WASHING AND SOAPING MACHINE.

Methods for Mordanting Cotton for Acid Coal Tar Colours:—

1st.—On tannic acid mordant fixed with tin crystals.

2nd.—Stannate of soda and sulphuric acid. Stannic acid can also be produced on fibre by passing in permanganate of potash, and afterwards in new bath with tin crystals.

3rd.—Alumina mordant.

4th.—Alizarine oil and alumina mordant.

The first method with tannic acid and tin is only employed for aniline blues soluble in water, which are dyed with alum in bath.

The second method is now seldom followed, and is performed in the usual way as mentioned for calico printing in two separate baths, while the method of fixation of stannic acid on the fibre with first bath of permanganate of potash at 2 to 5° Tw., followed by second with stannous chloride bath at same strength, and well washing afterwards is only of interest for the laboratory. One important point connected with this stannic acid mordant is that the cotton must be dyed immediately after mordanting, otherwise the mordant by standing will lose considerably the power of attracting colouring matters. The alumina is fixed on the fibre either by means of acetate of alumina, or by the aluminate of soda method, but alumina mordants are now generally connected with alizarine or Turkey red oil, and therefore the methods are the same as used for alizarine or Turkey red dyed calicoes, and have been elsewhere fully described.

Dyeing Methods for Coal Tar Colours.—The methods of dyeing vary according as the colours are basic or acid, and may be divided as follows:—

1st.—Aniline colours of basic character.

2nd.—The acid dyestuffs, comprising—

Acid aniline colours.
The eosines.
The azo colours.
Alizarine and allied dyestuffs.

ANILINE COLOURS OF BASIC CHARACTER.

Many methods were originally tried and recommended for the fixation of these dyestuffs on cotton, but they have, with almost one or two exceptions, been completely abandoned in favour of the one which relies on the employment of tannic acid. The complete range of colours can now be produced on cotton yarn, which will be illustrated by patterns and recipes in another part of this work; here only a general idea will be given.

The colours mostly produced on cotton yarn of this class are the

Reds, for which *safranine* and the *scarlets* derived from it and *magenta* are employed. Safranine gives from pinks to full blueish reds, which, however, are not so extensively used for cotton now as they used to be, since the eosines and azo reds yield shades which are brighter. Safranine colours, when fixed on cotton on tannic acid mordant, stand soaping fairly well, but not so air and light; but in this respect they are better than magenta. The scarlets produced with safranine and phosphine also stand soaping fairly well, but the cheaper scarlets produced with safranine and chrysoidine, although cheaper, are not so serviceable in this respect, since chrysoidine is a loose colour towards soap.

The production of scarlets by means of safranine by aid of these mixtures with either chrysoidine or phosphine, has lost its importance considerably since the introduction of azo scarlets, and lately of the Congo and benzopurpurine reds. For some purposes, however, the old scarlets with safranine are produced, but for a yellow the auramine is used instead of the two others, and with the advantages of cheapness in one case and greater fastness in the other. These safranine scarlets, however, cannot be considered in all cases as fast. A scarlet at one time pretty extensively dyed was produced by the aid of a yellow bottom with quercitron or flavine, and topped with scarlet.

Of scarlets and reds also of basic character, although not exactly belonging to this class, are the Vacanceine reds of

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Holliday, an example of which will be found among the patterns, where also the method of production on the fibre will be mentioned. Magenta, for the production of reds on cotton, is scarcely ever employed now-a-days; when so used, it is principally in connection with other colours, such as for browns on cotton velvets, &c.

Blues.—Several products of basic character are employed, the oldest of which is *spirit aniline blue* (opal blue). This product is now little employed, although at one time very largely used; it has been substituted, to a very great extent, by methylene blue. The aniline blues soluble in spirit range from blueish violets to greenish blue, but only the latter shade is now employed in the dyeing of cotton yarns. This greenish aniline blue, commonly called opal blue, gives very bright shades, which stand unrivalled, and which, although imitated, have never been surpassed by the other blues. The method of employment is as follows:—

Blue on Cotton with Spirit Opal Blue.

1st.—Mordant the cotton in soap bath, prepared with 10 parts Marseilles soap, dissolved in 100 parts boiling water; wring out as equally as possible and dry.

2nd.—Dye bath, prepared with acetate of alumina at 2° Tw., and corresponding amount of spirit solution of the blue (as below).

Enter cotton, work at first cold, then bring up to the boil, and boil one hour. According to the length of boiling, different shades of blue are produced; by bringing up to the boil, a reddish blue is formed, which becomes then greenish by boiling.

Dissolving the Opal Blue.

3 to 4 ozs., 2 to $2\frac{1}{2}$ grs. opal blue, are dissolved into one gallon (100 grs.) of methylated spirit at the boiling, by placing the vessel in boiling water; it is allowed to settle a few minutes, and filtered or sieved into the dyebath. Sometimes a little acetic acid is added along with the blue while dissolving.

This blue is still dyed on yarns, used along with silk, in the production of silk goods, and especially on those yarns which are polished. For a number of years solutions of these opal blues have been sold, being the acetate of triphenylated rosaniline, which is more soluble than the hydrochloric acid salt.

Methylene Blue, for cotton dyeing, is one of the most useful products ever introduced into practice. It is principally used for light and bright shades, which, however, do not equal those with aniline opal blue in brilliancy; but they are much cheaper, and also stand light better. Methylene blue is not so much used for dark shades by itself, as the colour produced is not very bright, but is pretty extensively used for the production of navy or marine blues in connection with methyl violet. For light shades, the cotton, after mordanting in sumach or tannin, and fixing in tartar emetic or the oxalate, is washed and soaped, and the dyeing is then performed in a hot (but not boiling) bath. Some dyers prefer to add a certain amount of soap to the dyebath, and state that they obtain brighter and softer shades.

Victoria Blues are employed both for greenish and reddish blues, but, owing to their instability against light, their use is not very extensive.

Of *Dark Blues* there are several on the market, some being simply mixtures of violets and greens, others self colours of recent introduction, possessing great fastness against soaping, and belonging in some cases to the induline class. The dyer has now at his command various products with which he can produce dark indigo blue shades by dyeing, and methylene blue is one of the principal. For

Dark Blues.

1st.—Mordant with 20 per cent. of sumach, or corresponding amount of extract, leave over night; wring.

2nd.—Pass through bath prepared with acetate of iron, black iron liquor, and 3 to 5° Tw.; work half-an-hour, wring, and wash.

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3rd.—Dye with methylene blue, with or without violet, until the desired shade is produced.

This method gives nice dark indigo-like shades on cotton cloth, imitating indigo fairly well, but they are not so fast. The method of mordanting may be inverted by mordanting with iron first, but without any advantage.

The VIOLETS and GREENS do not call for any special remark, and the methods of dyeing with these products are of the easiest, except that owing to their great attraction for the mordants, it is not an easy matter to obtain even shades; this is, however, only a matter of practical experience in the manipulations. They are often employed together in the dyeing of dark blues on sumach or iron mordants.

BISMARCK BROWN is a product still largely employed in cotton dyeing, both for yarn and cloth, and its employment also does not offer any special difficulty.

CHRYSOIDINE and PHOSPHINE are not so largely used now, the latter on account of its high price, and the former by its having been substituted by other dyestuffs possessing greater brilliancy or fastness.

GENERAL REMARKS ON THE DYEING WITH BASIC ANILINE COLOURS:—

Dissolving.—In the dissolving of these dyestuffs, it is well to use pure, and, if practicable, even distilled water, since calcareous water renders a portion of the product insoluble by forming a kind of lake. It is better to add the colouring matter in a vessel, and then pour the boiling water on it by gentle stirring, than to do the reverse, that is, to add the colouring matter to the boiling water. Before the solution is added to the dyebath, it is necessary to see that it is quite clear, that is, either thoroughly settled or sieved, or better, filtered, since any undissolved part will settle itself on the goods, and cause spots and irregularity in the dyeing.

Temperature of dyebath and duration of dyeing. No general rule can be given, but it may be set down as a good plan to begin dyeing in the cold, and bring up to the boil;

long boiling, however, is unnecessary, and, in fact, detrimental. Many dyers start the bath lukewarm, and dye without going up to the boil. One hour to 1½ should be the longest time employed for the dyeing process, which, according to requirements, may be considerably shortened. It is advisable to add the colouring solution in two or three portions to the dyebath, rather than to add it all at once.

Amount of dyestuff: ¼ to ½ per cent. for light shades, and up to 1 and 1½ per cent. for darker hues, may be taken as a general rule.

Amount of water in dyebath: From 10 to 20 or 30 parts of water to weight of cotton.

Compound Shades.

By the combination of two or more of the basic aniline colours an enormous amount of different shades could be produced, but they are seldom used for the purpose, since it is very difficult to get even shades, as the colours seem to precipitate each other in the dyebath, very likely owing to the common salt, which is very often added to some of these products as an adulterant. Aniline colours are very largely used for topping the shades obtained with dyewoods

Aniline Black.—Aniline black is not sold as a ready-made colouring matter; it is formed on the fibre during the dyeing process, but is nevertheless a basic dyestuff, and is therefore treated of here.

The first condition to obtain good blacks is to use an aniline that is as pure as possible, namely, an aniline containing no toluidines, which are generally found as impurities in the aniline sold.

For 100lbs. Yarn.*

Make up a dye beck with about 120 to 130 gallons of cold water, add to it—

16lbs. bichromate of potash dissolved in a sufficient quantity of hot water.

* I am obliged for these three recipes to the kindness of Dr. Dreyfus, of the Clayton Aniline Company.

PAIR OF COUPLING LINKS.

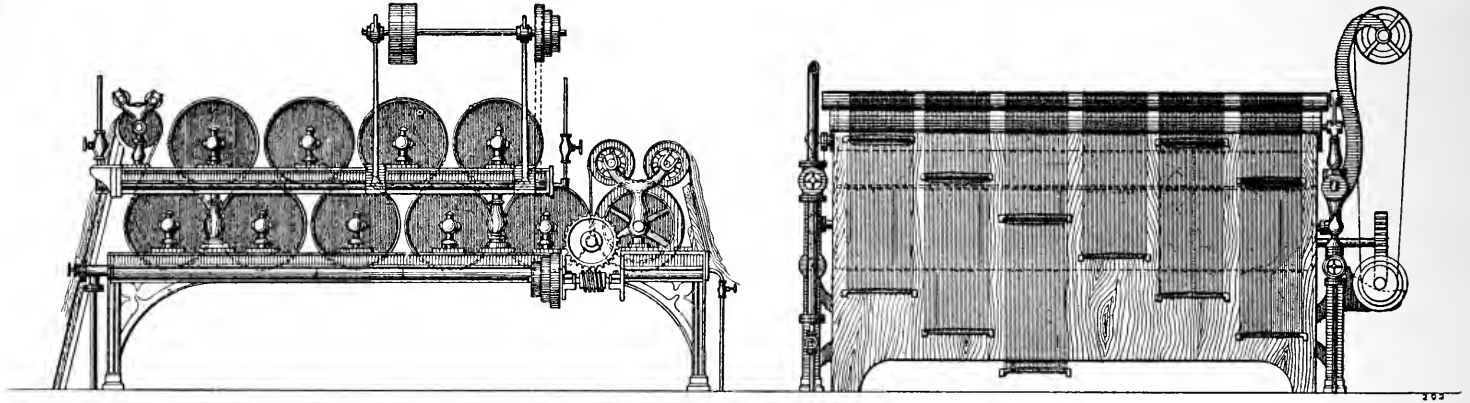

PLATE IX.—MATHER AND PLATT'S PATENT HANK YARN DRYING MACHINE.

11lbs. sulphate of iron dissolved in hot water.
16lbs. sulphuric acid at 168 Tw.
Then dissolve separately 8lbs. SPECIAL OIL FOR BLACK in 12lbs. hydrochloric acid at 32 Tw., add 2 galls. water, and put into the dye beck.

Stir the beck well up. Then enter the yarn rapidly, work it very briskly for three-quarters of an hour, in the cold dye beck; then heat up gradually, and bring it to the spring boil in another three-quarters of an hour; leave in five minutes; lift and wash well.

If a blue-black is required, soap in a hot soap bath half-an-hour.

This gives the best black; cheaper blacks can be produced by using less of the materials.

Instead of special oil for black you may use—

11lbs. SPECIAL SALT FOR BLACK.
2lbs. hydrochloric acid.

For 100lbs. Cotton, either Yarn or Piece Goods.

170 to 200 gallons water, to which add—

1 15½lbs. bichromate of potash dissolved in 7 galls. boiling water.
2 2½ galls. of cold water.
⅘ths. of a gallon of sulphuric acid at 168 to 170° Tw., or in weight 14¾lbs.
3 5½lbs. nitrate of iron (48° Bé, or 100° Tw.)

If aniline is used—

4 2½galls. of cold water.
10¾lbs. muriate acid at 36° Tw. (22° Bé.)
8¾lbs. aniline oil for dyeing,

If aniline salt is used—

4 2½galls. hot water.
12¼lbs. aniline salt.

These materials are added to the dyebath in the order given above. Stir up the bath well, and then enter the goods. Turn without stopping for piece goods, and work well in the bath for yarns; ¾ hour after having begun to dye, start heating the bath gradually so as to take another ¾ hour to get to the boil. Then stop the heat, work another quarter of an hour in the dye bath, then take out the goods

and *wash them thoroughly*. After washing, pass the goods (¼ hour) through a bath heated up to 50° centigrade (120° Fahrenheit), and containing 1 oz. of vitriol to every 6 gallons of water, say, 1 part in weight of vitriol to 1,000 parts in weight of water. Wash well and soap at 70/80° centigrade (160° to 170° Fahrenheit), with 7 lbs. good olive oil soap. The soaping is to be specially recommended in preference to a passage through carbonate of soda. The goods that have been soaped feel softer and do not dust so much as those passed through soda. The dyeing is done in wooden dye becks with a copper coil to heat the bath. The bath must be heated by dry steam, and not with live steam—this latter would dilute the bath too much.

The nitrate of iron for above is made as follows:—

In a stone jar put 50lbs. nitric acid at 36° Bé (66° Tw.), and add, gradually, 6 to 7lbs. hoop iron; when the iron is dissolved bring the solution to the degree required.

Fast Bronze Black for Sizing.

For 100lbs. Cotton (Yarn).

100galls. water.
10 ,, solution C.
10 ,, solution D.

Mix well, and then enter the cotton. Dye 15 minutes cold, and then gradually heat up to 160° F. in 30 to 45 minutes. Wash well. Dry and size.

SOLUTION C.

100galls. water.
50lbs. pure aniline F.F.
150lbs. sulphuric acid.

Mix well.

SOLUTION D.

100galls. water.
150lbs. bichromate of potash, or soda.

Dissolve and mix well.

It is a curious fact that aniline black is dyed much more largely on the Continent, principally in France, in the

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neighbourhood of Rouen, than in this country. It is also of interest to note that some cheap blacks are dyed there with about 4 to 5 per cent. of aniline. This is made possible by the employment of concentrated baths and specially constructed machines, on which a large quantity is dyed at the same time. In the majority of cases, the cold process is employed when dyeing with aniline black, the yarn being left overnight in the baths. Sometimes the aniline black is topped with logwood, or with aniline violet.

By a modification of the ordinary aniline black dyeing process a colour is produced which will stand a moderate bleaching process, and can be employed in such goods as have been woven in white grounds with black patterns.

Phenylendiamine Brown.

By following the same process as for aniline black, the author obtained, some years ago, very fast brown and bronze colours by means of phenylendiamine. The only drawback to its employment for cotton dyeing is its price; otherwise, the colours are of such fastness, that they would be very usefully employed in practice.

ACID COAL TAR COLOURS.

Of these only the blues are worth mentioning as being largely employed. They are found on the market, either capable of being fixed on cotton simply in a bath with alum, or they can be dyed on tannin and tin mordant with alum in bath, as mentioned before.

The cotton blues have lost their importance considerably since the introduction of methylene blue, but they are still used to a certain extent, and yield shades which cannot be produced by any other means, and at a low price. The colours produced, however, are very loose against washing, and are not fast to light, although they stand exposure to a certain extent. A method of employment of great importance some years ago for the dyeing of these

soluble aniline blues (cotton blues) on cotton is the following:—

Cotton Blues for light or medium shades—

1st.—*Mordant*—

20lbs. alum	400 grs.
10lbs. soda crystals	200 grs.
2½lbs. tartar emetic	50 grs.
5 galls. water	1 litre.

Dissolve the alum in the boiling water, leave to cool, and add the other ingredients; when all dissolved, leave to settle, and use clear liquor.

2nd.—*Dyebath* for 100lbs. cotton. Prepared with:—Solution of colouring matter (about ½ to 1 per cent. or more, according to strength of dyestuff and shade required), and add—

1¼ galls. of above mordant.....12½cc. per 100 grs. cotton.

Dye at a temperature of 80 to 90° C.

Dark Shades.—Dark blues are produced by simply preparing a bath of the colour solution—

Along with 10lbs. of alum,
And 5lbs. soda crystal,
For every 100lbs. of cotton.

As may be easily imagined, these shades never stand washing with water. The dyebaths are always kept, since they are not exhausted, and still contain a large amount of dyestuff.

The other acid aniline colours, such as acid magenta or acid violet, &c., have no special interest for cotton dyeing, but are of great value for the dyeing of wool.

THE EOSINES.

These dyestuffs have lost their importance considerably during the last few years, owing, first, to the fugitiveness of the shades produced, but more especially on account of the introduction of some azo reds of blueish shade, which are faster against light, and, moreover, much cheaper in price. For pinks of a very bright line, the

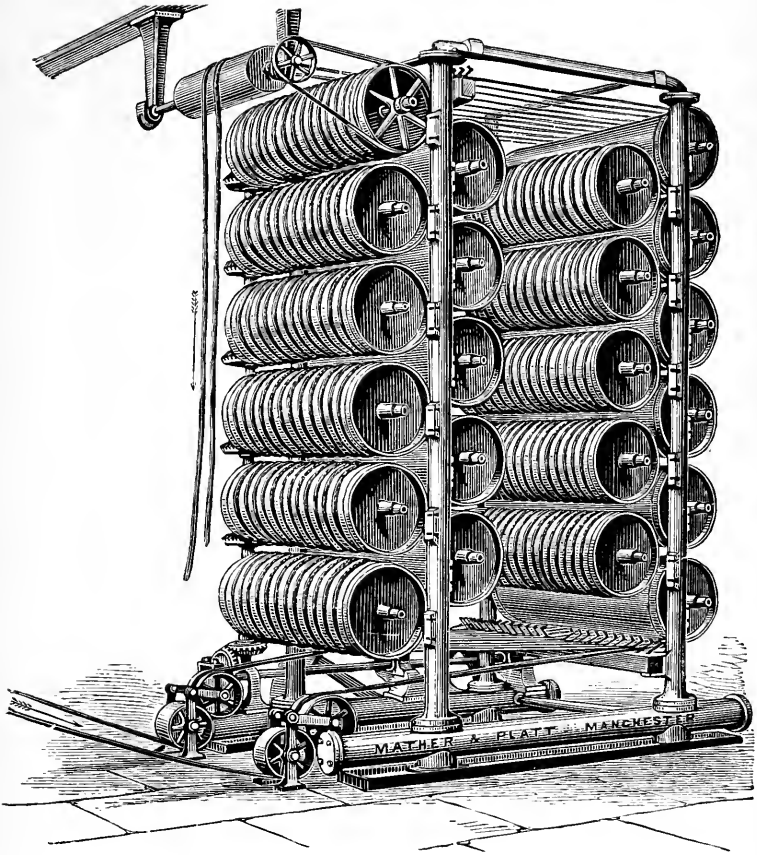


PLATE XI.—WARP DRYING MACHINE.

eosines are, however, still employed, and, in the majority of cases, on bleached cotton, without any mordant, and by the addition or not of acetic acid in the bath. Eosines for fuller shades can be dyed on cotton, mordanted with soap and acetate of lead solutions, the yarn being alternately first in the soap then in the lead bath, and the operation repeated, in order to fix a lead soap on the fibre, which, after washing, is then dyed in the eosine bath. Although this method gives fine shades, it has the drawback of being liable to blacken if exposed to sulphuretted hydrogen fumes. The method of mordanting with alizarine oil, and then acetate of alumina, is free from this objection.

Another method of mordanting cotton for eosine colours is as follows:—

1st.—Boil cotton for half-an-hour in strong soap bath—
10 parts soap to 100 of water; wring out.

2nd.—Work in red liquor (acetate of alumina 12° Tw.); lift, wring, wash.

3rd.—Dye in lukewarm bath, allow to cool down during the dyeing. Add the colours gradually, and for yellower shades add further a small amount of acetic acid. Eosine colours are very fugitive against light, and of course do not stand soaping.

THE AZO COLOURS.

The number of azo colours found on the market, and their diversity of name, make it almost an impossibility to describe them individually, and therefore only a few broad hints will be given here, the more so that all the manufacturers of coal tar colours, as a rule, give the method of employment of their products.

Of the orange azo dyestuffs few are found of utility, while the scarlets are very largely employed.

Of the various methods of employment, we may mention that very often, and this especially in the case of cotton cloth, no mordant at all is used, the goods being simply impregnated with the dyestuff solution A soap and acetate

of alumina mordant is often employed, or alizarine oil and acetate of alumina mordant may be used. In no case are colours produced which stand even a good washing with water alone, not to mention soap, which would strip the colours off entirely. These remarks will be supplemented by dyed patterns, with particulars, in another part of this work.

In later times special azo reds have been introduced, which, like some of the older aniline soluble blues, only require alum for their dyeing on cotton.

In another part of this work will be found dyed patterns, with corresponding methods of employment of this interesting class of dyestuffs, being communications from coal tar colour manufacturers.

Here will be described only the general methods of application of the different azo colours.

Azo Oranges, Tropeolines, &c., are not largely used for cotton dyeing, and in the majority of cases are utilised simply as impregnation colours. The cotton is previously boiled in a soap bath, then lifted, cooled, wrung, and worked in the dyebath, which is made rather concentrated with the addition of a little alum.

Azo Scarlets (Ponceaux). Mordant—

20lbs. alum.
10lbs. soda crystals.
3¼lbs. tartar emetic.

Dissolve in sufficient water, allow to settle, draw off clear liquor, and make up to 70° Tw. Work cotton in this bath cold; lift, wring out; dye in very concentrated bath of the dyestuff, at about 60° C.

Another method—

1st.—Work in stannic chloride solution at 5° Tw. for half-an-hour, wring.

2nd.—Work half-an-hour in second bath, with acetate of alumina, 5° Tw.; wring, wash slightly.

3rd.—Dye in concentrated bath at about 60° C.

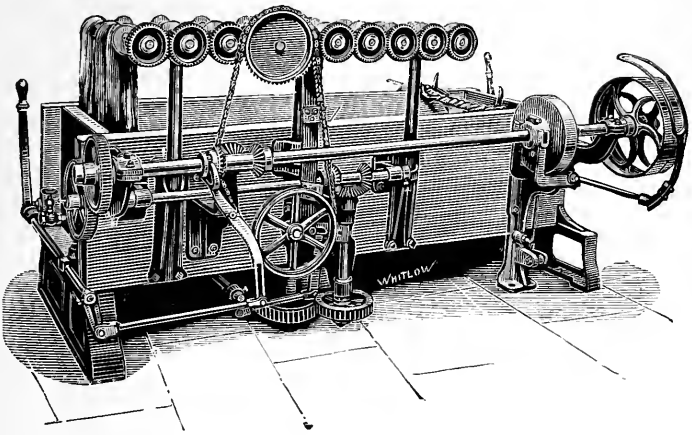


Fig. 1.

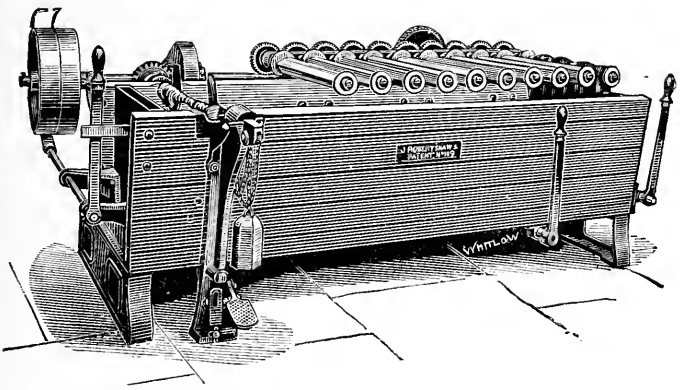


Fig. 2.

PLATE XII.—ROBERTSHAW'S DYEING MACHINE.

NEW CLASS OF AZO COLOURS.

Congo Class.—These products, which come on the market in such a variety of shade, and which are very interesting, as being the only class of coal tar colours dyeing cotton without mordants, are applied on cotton generally in an alkaline bath. The following recipes are due to the kindness of Messrs. Bryce and Rumpf, the Manchester agents of the Bäyer Colour Works, Elberfeld, who have given special attention to these products. These dyestuffs, with the exception of chrysamine yellow, which is fast, do not stand light so well as might be wished; but they are found very useful for a variety of purposes. The most interesting property of the colours produced on the fibre is that they stand soaping, and in many cases boiling soap exceedingly well.

They dye cotton, wool, silk, jute, linen, half-silken, half-woollen, half-linen goods in a boiling bath without a mordant, and owing to their great affinity to each other they allow a general combination, and thus the production of any required shade from yellow to red, violet, blue, olive and brown.

In order to make the colours fall on better still, and more especially to obtain full dark shades, it has proved advantageous to add weak alkaline or neutral acting mordants to the dye-bath, such as soap, potash, soda, phosphate, silicate or stannate of soda, salt or glaubersalts, that the dyer may have it within his power to exhaust the bath more or less.

In consequence of their homogeneousness and affinity to the fibre, the whole of these products allow, whenever it is contemplated to produce mixed shades, the addition of two or more of these colours to the dye-bath simultaneously, and no longer by degrees, as has been the general rule hitherto.

As regards fastness to air and light, these dye-stuffs are at least quite as good as any aniline colours known hitherto. The chrysamine will retain its colour even if exposed for months to the most concentrated sunlight.

Besides the above mentioned properties, these interesting new products have the singular peculiarity of serving as a mordant for all other aniline colours, the azo or naphthol colours excepted, *i.e.*, if the cotton has first been dyed, and has then been topped with other aniline colours, the shade becomes fixed in the most perfect way without the cotton being tanned first, or prepared with another mordant; thus in this way also, an unlimited number of compound shades can be obtained.

CHRYSAMINE.

This dye-stuff is against air and light the fastest aniline colour in existence. It is supplied in paste as well as in powder, for printing or dyeing purposes. Chrysamine has proved of great importance as a direct yellow, also for topping other colours, or as a substitute for annatto with turkey red.

On cotton not mordanted.—For a medium yellow shade dye with

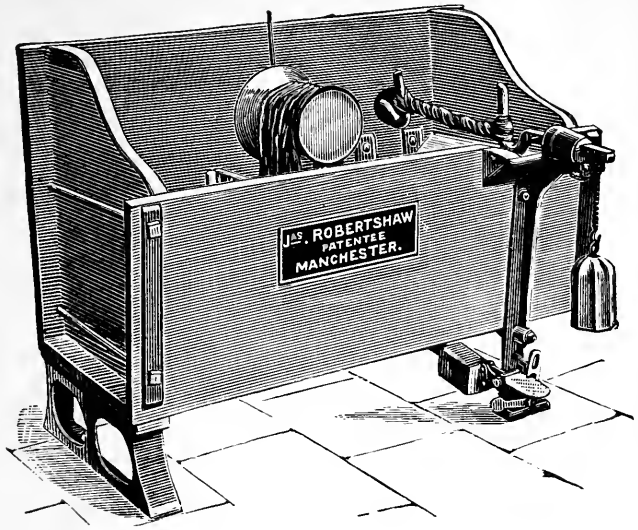
10 per cent. phosphate of soda.
2½ per cent. olive oil soap.
1 per cent. chrysamine powder.

Short liquors are recommended. Raise the bath to boiling point, enter the yarn and dye for one hour, turning off steam. Should the dyeing be done at the boil, a reddish yellow will appear. Wash well after dyeing.

The first bath not being exhausted may be used again, for further parcels three-fourths or less of the former quantity of colour or mordant are required; of the latter finally no more need be added.

Jute, hemp and linen goods are dyed the same as cotton.

Silk should be dyed the same as cotton, and brightened by acetic acid. Dyeing in a pure soap bath (without the phosphate of soda) may also be done, and is especially to be recommended for combination dyeing with green, methyl-violet, magenta, saffranine, etc.



Fig, 1.

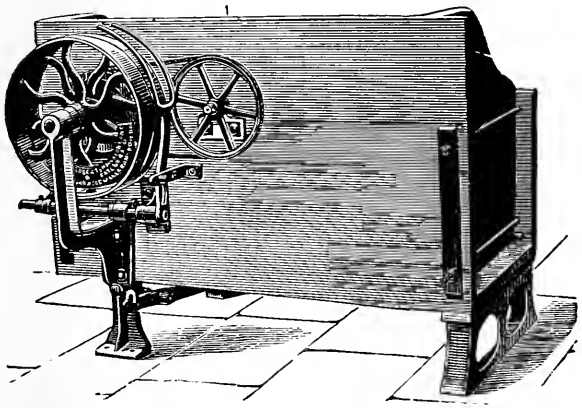


Fig. 2.

PLATE XIII.—SIZING AND WRINGING MACHINE.

Half-silken goods are dyed the same as the recipe for cotton yarn, and a fine fast yellow is obtained in one bath.

Half-woollen goods are dyed with phosphate of soda alone (no soap), boiling for one hour.

HESSIAN YELLOW.

This product does not fall on so well as the chrysamine, and yields a somewhat redder shade.

Prepare a bath of

25 litres water (5½ gallons)
to 1 kilo cotton (2⅕lbs.)
with 100 grammes common salt (3½oz.)

raise to 65° C. or 149° F., add the solution of colour, and now enter with the cotton, adding at the same time 100 grammes (4oz.) Turkey red oil, dye up to shade for about half an hour, rinse in cold water and dry. If dyed in copper, a reddish yellow results, therefore wooden, or tin vessels should be used.

BRILLIANT YELLOW.

Dyes on cotton a fine greenish yellow, in a weak acidulated bath; but contrary to the other yellow dye-stuffs it has this peculiarity, that it turns red by soap or alkali.

Prepare a liquor of

25 litres water (5½ gallons.)
to 1 kilo cotton (2¼lbs.)
with 200 grammes common salt (7½oz.)

enter the cotton, add the solution of colour and

20 grammes of acetic acid of 35 per cent. (¾oz.)

and dye for about half an hour at 60° to 70° C. = 140 to 150° F., wring and rinse slightly.

BENZOPURPURINE 1 B AND 4 B, DELTA-PURPURINE G AND 5 B, CONGO G AND 4 R.

All these dye-stuffs will yield fiery scarlet and Turkey red shades, fast to soap. Congo and all products of the

same denomination dye a full yellow to medium red, but have the property of being very sensitive to acids, though for many purposes this may not be important. Benzopurpurine 4 B, although in its other properties resembling Congo, will withstand diluted acids, and consequently resists air better. The benzopurpurine 1 B, Delta-purpurine G and 5 B, are the red products fastest to acids of this class of colours. The latter, therefore, will be used wherever colours fast to acids and suitable for underclothing purposes are wanted. They fall on somewhat more slowly than Congo and benzopurpurine 4 B, but by increasing the quantity of mordant, as already stated, they dye stronger and more quickly.

On cotton not mordanted.—Dye boiling for one hour with :—

3 to 5 per cent. carbonate of potash.
2½ per cent. soap.
3 per cent. of the respective dye-stuff.

The use of water containing lime must be avoided, therefore before dissolving the colour, and before adding the soap or the respective mordant, remove the lime.

Instead of carbonate of potash, the following mordants will also do—

5—10 per cent. phosphate of soda,
or 3—5 per cent. soda crystals,
or 5 per cent. borax,
or 5 per cent. silicate of soda,
or 5 per cent. stannate of soda,
or 5—10 per cent. glaubersalts.

To improve the resisting properties of this colour to light and air, pass the goods, after dyeing, through a cold bath, to which add

5 per cent. soda crystals.

A brighter and deeper shade of red is obtained by giving the goods after dyeing a second cold bath, to which

5—10 per cent. Turkey red oil solution

is added.

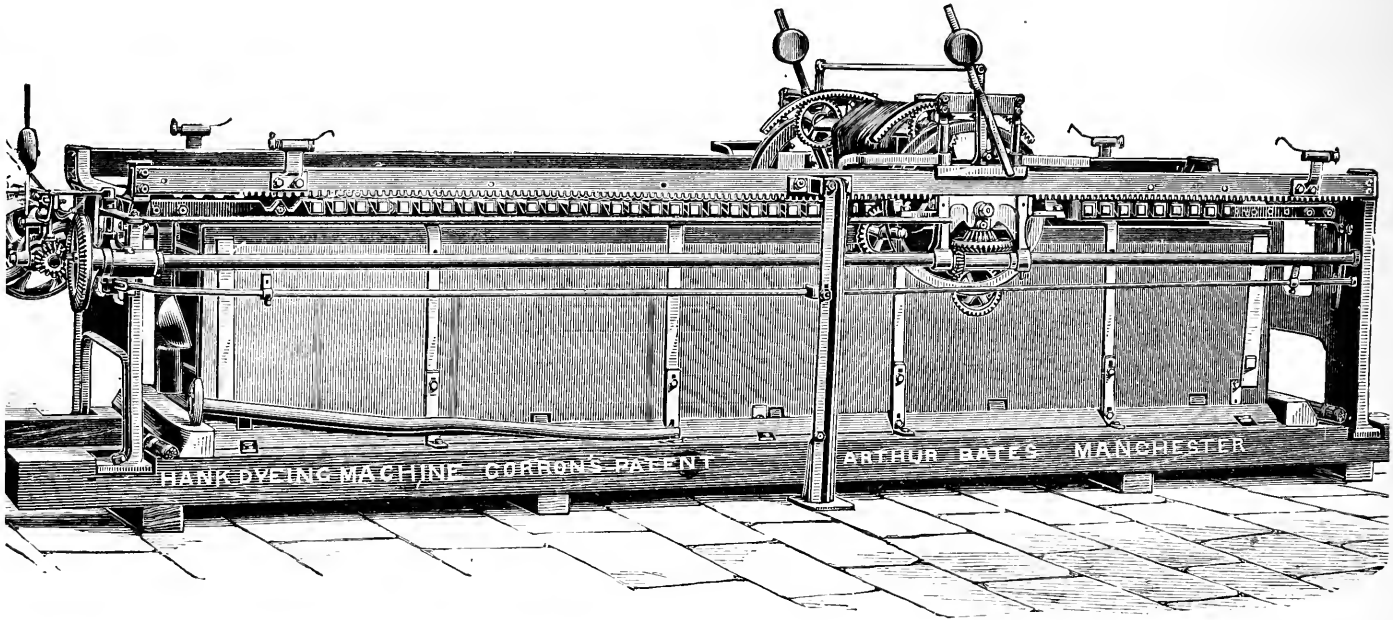


PLATE XIV.—CORRON'S DYEING MACHINE.

This Turkey red oil solution is made up as follows—

5 parts soda dissolved
in 75 ,, water, then
25 ,, Turkey red oil (neutral)

added and the whole well mixed.

After taking the goods through the above-mentioned cold water bath (with from 5 to 10 per cent. of this Turkey red oil solution added), dry without further washing.

If this Turkey red oil bath is applied, of course the soda bath mentioned above is left out.

The dyebaths may be kept for further use, and for new lots of cotton proportionately less colour and mordant have to be added to the original bath.

Pink shades are got by adding very little, say one-tenth per cent. of dye-stuff.

On silk a full red shade is dyed with:

5 per cent. phosphate of soda,
or 5 per cent. olive oil soap,
and 3 per cent dye-stuff,

kept just under the boiling point for three-quarters of an hour; and the baths may be retained for further use.

Half-silken goods are dyed same as silk, and a fine red is obtained in one bath.

Half-woollen goods: In order to get the wool as well as the cotton to correspond in shade, add to the solution of colour

2 per cent. carbonate of potash,
8 per cent. phosphate of soda,

dye boiling for one hour.

Jute, hemp, and linen goods are dyed like cotton.

ROSAZURINE.

This product dyes cotton a fine clear blueish-red, and is well adapted as a substitute for saffranine, or to give the colours as stated under, in the last recipe, a more blueish and yet brighter shade.

Resisting acids very well, and dyeing vegetable and animal fibre a perfect even shade, it is besides well adapted for dyeing half-silken and half-woollen goods in one bath.

Rosazurine dyes the same as benzopurpurine or Congo.

Rosazurine dyed on wool is exceedingly fast to milling.

HESSIAN PURPLE.

This colour is in shade similar to rosazurine, but not so bright; further, it does not stand the light as well as the latter.

Hessian purple dyes with common salt only, just under the boiling point 205 to 210° F. for half-an-hour; then wring, and without rinsing, turn in a solution of 5 per cent. soda crystals, wring and dry without rinsing. By giving the soda solution an addition of a little neutral Turkey red oil, the shades will turn more brilliant and more fiery. All vegetable fibres are dyed in the same manner.

AZOBLUE, BENZOAZURINE R AND G.

These products also dye in one bath, yielding respectively a blue violet and a medium blue shade; they correspond generally with the dyestuffs mentioned above, but absolutely resist acids, even strong nitric acid, and to a great extent air and light.

Whereas the yellow and red products of this class dye the vegetable as well as the animal fibre one and the same shade; the azoblue or benzoazurine dye the animal fibre a more reddish shade than the vegetable fibre. The evenness of both fibres (half-silk and half-wool) is, however, easily obtained by adding the corresponding colour, which dyes the animal fibre alkaline, *e. g.*, alkali blue (acidulated in the water bath), or topping in a fresh bath, *e.g.*, methylene blue.

On cotton not mordanted.—Dye boiling for one hour with —

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5 to 10 per cent. glaubersalts,
2½ per cent. soap,
2 to 3½ per cent. azoblue or benzoazurine,

according to shade required.

Instead of glaubersalts, 5 to 10 per cent. phosphate of soda may be added.

While in the dye bath the shade will turn reddish, and on lifting, the yarn must be well rinsed in cold water, when a blueish tinge appears; dry in an airy room. (Azoblue if dried hot will turn reddish, but will lose this red tinge as soon as the yarn has cooled).

The liquors are not exhausted, and may therefore be kept for further use. Only two-thirds of the quantity of colour and glaubersalts, or less even, are taken in the following bath (and of the glaubersalts finally none).

Water containing lime must be avoided, therefore, before dissolving the colour, and before adding the soap or the respective mordant, remove the lime. If indigo shades are wanted, the addition of a small quantity of chrysamine to the dye bath gives good results (before adding the latter it must, however, be thoroughly dissolved in boiling water).

To 100 parts of benzoazurine, 3 to 5 parts of chrysamine powder are added (according to the shade of indigo required). All such shades dyed on cotton with benzoazurine and chrysamine are considered superior to indigo, as the colour does not rub off in the least.

For combination with white, the cotton dyed with azoblue or benzoazurine is first rinsed in a lukewarm soap bath, so that the colour mechanically adhering to the fibre is removed, and after that it is requisite to rinse thoroughly again in cold water.

Benzoazurine—just as well as the other colours belonging to this class—has the peculiar property of acting as a mordant by itself; therefore, if the cotton, for instance, is first dyed with a bottom of benzoazurine, any other aniline colour (magenta, imperial green, emerald green, saffranine, violet, &c.) may be dyed on the yarn without adding any

other mordant for topping, thereby immensely facilitating shading off into other tints.

On silk dye with—

10 per cent. phosphate of soda,
5 per cent. olive oil soap,
3 per cent. colour,

just under the boiling point 205 to 210° F., for three-quarters of an hour, reviving with acetic acid.

The liquors may be kept for further use.

Half-silken goods are dyed the same as silk.

Half-woollen with phosphate of soda only (no soap).

Jute, hemp, and linen goods are dyed like cotton.

The following dyestuffs—chrysamine, benzopurpurine, congo, azoblue, benzoazurine—are exceedingly suitable for dyeing lime, plaster of Paris, soap, &c., without any addition whatever.

Corozo-nut buttons, wood, are dyed same as cotton.

CONGO-CORINTH AND CONGO-CORINTH B,

Which give dark purplish reds, are appropriate for dyeing cotton in one bath without previous mordanting, and besides, are recommendable for mixing purposes. The dye method is the same as with the benzopurpurine or congo, and the mordants best adapted for the purpose would be—

Borax and common salt,

or

Phosphate of soda and soap.

ALIZARINE COLOURS.

Of the applications of alizarine for cotton dyeing, only that for the production of red deserves attention. Other colours, of course, can be produced with alizarine on cotton with different mordants; but, with the exception of purples, and to a less extent chocolates or browns, alizarine is almost exclusively employed in cotton dyeing for the production of reds, turkey reds, and alizarine reds.

The dyeing of reds on cloth, and the theory of the formation of the red lake, have been extensively treated in the author's previous work on "Printing," and will, therefore, not be mentioned here. The following remarks will only treat upon the dyeing of reds on cotton yarn, and in another chapter mention will also be made of the machinery or apparatus employed in some dyeworks, principally on the Continent.

ALIZARINE RED.

On Cotton Yarn 100*lbs.*

1st.—Boil with 3 per cent. caustic soda; wash and dry.

2nd.—Mordant with acetate of alumina at 6 to 8° Tw.; dry and leave to air, or preferably age in a damp and moderately heated stove.

3rd.—Pass for half-an-hour in a dunging bath containing 10lbs. chalk (or whiting), or dung with dung substitutes such as binarseniate of soda; wash well.

4th.—Dye in bath with 7 to 8 per cent., alizarine 20 per cent., blue or yellow shade, according to colour required.

3 to 5 per cent. alizarine oil,
1 to 2 per cent. Sicily sumach,

or corresponding amount of tannic acid. Start cold, heat gradually so as to reach about 65 to 70° C., in from 1 hour to 1½ hours; lift out and wring. If the yarn be washed it must only be done slightly; dry.

5th.—Give an oil bath prepared with 10 parts alizarine oil in 100 of water; dry.

6th.—Steam 1 hour.

7th.—Soap with 3 to 5 per cent. olive oil soap, and dry.

N.B.—Some dyers prefer to add some tin crystals to the acetate of alumina mordant; for the purpose, however, acetate of tin would be preferable to the chloride. Others again prefer to add some tin crystals to the oil bath before steaming, by the addition of ammonia at the same time. Others prefer to add stannous chloride solution, and a small amount of soda crystals, say 1 to 2 per cent. each,

while soaping after steaming. Some even mordant the cotton previously with stannate of soda, and pass them in weak sulphuric acid. As is well known, the addition of tin improves the beauty of the reds considerably, by imparting to them a yellower and brighter shade. The best method of applying tin is, however, the one recommended by M. Horace Koechlin, at a sitting of the Societé Industrielle de Mülhouse. By this method the tin is applied in the dyebath, and in the form of a precipitated hydrate, being in fact the precipitate produced by treating a stannic solution by means of carbonate of soda.

Brighter and fuller reds are in all cases obtained by giving one or more oilings at the beginning, by means of the ordinary alizarine oils (prepared from castor oil), and these reds are distinguished from the others by applying to them the name of Turkey reds, a name which really belongs to the reds produced by the long process, with tournant or emulsive oils. The long process has been mentioned elsewhere, and need not be repeated here.

The short process for

TURKEY REDS,

Cotton yarn 100*lbs.*—Is as follows—

1st.—Boil cotton 1½ hours with 3 per cent. Greenbank caustic soda, wash and dry.

2nd.—Mordant in a solution of alizarine oil at 5 to 10 per cent., wring and dry in stove at about 45° C. for 8 hours.

3rd.—Mordant, with acetate of alumina, at 6 to 8° Tw., dry in stove 8 hours.

4th.—Dunging bath, containing 10lbs. chalk, 5lbs. cowdung, temperature 60° C. for one hour, wash well.

5th.—Dyebath—Alizarine 7 to 8 per cent., alizarine oil 1 to 3 per cent., sumach 1 per cent. Start cold, heat gradually up to 65° C. and keep it at this temperature up to 70° C. for 20 to 30 minutes. Lift out. Dry at as low temperature as possible.

6th.—Steam for 1 hour.

7th.—Soap—with 3 per cent. soap,
1 per cent. soda crystal,
1 per cent. tin crystal,

at the boil for 1 hour or under pressure, wash and dry.

This is the outline only of the method which is generally followed, but it undergoes very many modifications at the hands of different dyers. Some give a steaming after the first oiling, and steam also after the last oiling. Others prefer to oil the yarns two or three times at first instead of only once, and thus dispense with the oiling at the end. Another important modification consists in employing a basic alumina mordant instead of the acetate of alumina by taking

About 20 per cent. to 25 per cent. alum to weight of cotton,

dissolving in boiling water, and making up a bath at about 35° C. with sufficient water only that the yarn can be easily laid in the bath after having been well impregnated. Before entering the yarn in this bath, the alum is rendered basic by the addition of about 6 to 7lbs. soda crystals, or a corresponding amount of soda lye in sufficient quantity to form a basic mordant, without, however, precipitating any hydrate of alumina. The yarn is left in this basic mordant over night, and next morning, after wringing, is either washed, or preferably dunged, and then dyed in the usual way.

Although the method of mordanting cotton cloth by the alkaline process, viz., aluminate of soda, is practised with regularity in some printworks, the author does not (at the time of writing) know of any instance of its being in successful employment in any works for the dyeing of yarn; but from many experiments undertaken it seems very likely that the method of mordanting cotton yarn by means of aluminate of soda will be introduced in the practice of the works at no very distant date, and he hopes to be able to publish the results obtained by experiments, now proceeding, in another part of this volume.

A modified method of the old process of turkey red dyeing is still employed in practice; it consists in oiling

the yarns three times by a white bath of emulsive oil and soda, exposing every time to stoving. The mordanting is effected also by means of a basic alum bath, and after dyeing, no oiling is necessary, but the goods are steamed and soaped as usual.

In regard to the employment of tin mordants, along with alumina, the same remarks apply here even with greater importance than in the dyeing of alizarine reds. The employment of the precipitated tin oxide in the dyebath, along with the alizarine, and which, according to the communication already alluded to of M. Horace Koechlin to the Société Industrielle of Mülhouse, has been used at the Loerrach works (Koechlin Baumgarten) for the last ten years, is a very sensible application, which will give excellent results. It has been so far principally used for cotton cloth dyeing, but will also be found very effective for yarns.

OTHER ALIZARINE COLOURS.

ALIZARINE PURPLES.

These are pretty extensively produced, although to a considerably less extent than the reds.

They are obtained as follows:—

1st method.

1st.—Mordant cotton with alizarine oil (oleine) in the usual way as for reds, and dry.

2nd.—Work in acetate of iron (black iron liquor) at about 3 to 5° Tw., according to the shade wanted, dry and air 12 hours.

3rd.—Pass through hot whiting bath of 10 per cent. chalk, rinse, &c.

4th.—Dye in alizarine bath, with or without oleine or sumach in the bath. Enter cold, bring up to the boil, boil 20 minutes, wash.

5th.—Soap with 5 per cent. soap, and dry.

This colour can be topped with methyl violet, by which it is brightened very considerably.

2nd method. 100lbs. cotton.

1st.—Lay overnight in 20lbs. sumach. Wring.

2nd.—Work in acetate of iron (black iron liquor) at 4° to 6° Tw. for 30-45 minutes, and wring.

3rd.—Give a dunging bath, with chalk or silicate of soda. Wash.

4th.—Dye with alizarine, and finish as before.

By connecting acetate of alumina with the iron mordant in either method, 1st or 2nd, and then drying, dunging, and following all the other operations, fast colours are obtained, which can be greatly modified by the addition of other dye-stuffs to the dye-baths, such as fustic, quercitron bark, etc., and a great many shades can be produced. The alizarine will already by itself give a different shade, according as it is of a yellow or blueish hue.

Of the other alizarine colours very few applications have been made, either for the dyeing of yarns or cloth. Alizarine blue, for instance, is too expensive to compete with indigo on the one side, or with aniline colours on the other, while alizarine orange, also, is costly, and cannot eve compete for shade with chrome orange.

CERULEINE OLIVES.

These might also be dyed with advantage, owing to the peculiar shades produced, but the application of this dye-stuff is not at all extensive in cotton dying, owing to the costliness of the mordanting operation. The best method of mordanting is by means of oxide of chrome, and as is well known, no very satisfactory method exists, except the alkaline methods, which have been fully described in the work on "Printing," in which a sample has been inserted of gallocyannie, along with bark dyed on cloth mordanted with chromium alkaline mordant. This method of mordanting is also too costly for extended application.

An interesting application might be made of the new class of azo colours belonging to the class of Congo red,

for utilising them in the soap baths where alizarine shades are being soaped, which would then be modified according to the dye-stuff employed.

DYEWOOD EXTRACT COLOURS.

The dyewood extracts are still largely used in cotton dyeing for a great range of shades, but principally for the following:—

Blacks, Greys, &c.
Browns.
Yellows.
Reds.

BLACKS.

Logwood still holds a strong position in the dyeing of blacks, and is far from having been displaced by aniline black for ordinary purposes. In one branch, however, the black dyeing with logwood has suffered to a certain extent, and it is the production of fast blacks with indigo bottom that has been to a great extent displaced by aniline black. The logwood cotton blacks are divided into iron blacks and chrome blacks.

The Iron Blacks.

1st method. 100lbs. cotton.

1st.—Work cotton in acetate of iron at 6° Tw. (pyrolignate of iron or black iron liquor) in the cold until well impregnated. Wring and dry.

2nd.—Pass through hot chalk bath with 10 per cent. of whiting 30 to 40 minutes, at 120 to 150° F., then wash well.

3rd.—Dye in fresh bath with decoctions from

75 to 100lbs. logwood or corresponding amount of extract.
10lbs. sumach ,, ,,

and, if necessary, same amount of fustic. Enter lukewarm, and bring up to boil until black is perfectly developed.

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A better black is produced if some acetate of alumina be employed at same time with the iron liquor, and the yarn be aged or aired after drying and before dunging, but the difficulty connected with this method is to obtain even shades.

2nd method. 100lbs. cotton.

1st.—Work an infusion of 20lbs. sumach, and lay overnight in this bath. Wring.

2nd.—Pass through clear lime water (which will fix the tannin as tannate of lime).

3rd.—Through acetate of iron at 4 to 6° Tw. for 1 hour; wring, and preferably leave in heap or air for some hours.

4th.—Through clear lime water again and wash.

5th.—Dye in logwood bath as above, with logwood, or logwood extract and fustic, but without sumach.

Instead of using sumach in the first bath, any other astringent may be used.

The first limebath is often left out, and the second is also replaced by chalk or any other dunging bath, the object being of course to fix the tannate of iron on the cotton. Catechu is also often employed instead of sumach for fast blacks, and after the iron bath a bichromate of potash bath is often resorted to.

Nitrate of iron, or rather persulphate of iron, is in some cases employed instead of the acetate, and no airing is then necessary to oxydise the ferrous oxyde to the ferric as in the last case.

Chrome Black. 100lbs. cotton.

1st.—Prepare bath with extracts corresponding to

100lbs. logwood.
10lbs. bark.

Boil cotton in this bath (without previously scouring) for 1 hour, and then wring.

2nd.—Enter bath prepared with

4lbs. bichromate of potash.
2lbs. sulphate of copper.

Work 1 hour at about 100° F.; wring and wash.

3rd.—Re-enter 1st bath, work for 1 hour at about 150° F.; lift out and wash.

Instead of re-entering the first bath, a new bath of log-wood may be used, in this case the three baths being kept as standing baths, to be refreshed after every lot with new ingredients.

Black yarns are generally softened after dyeing, either by an oil and soap bath, or by special preparations, such as so-called soluble oils, and now preferably by means of oleine or alizarine oils.

DYEING AND FINISHING OF BLACK ITALIAN COTTON CLOTH.

The dyeing of these goods forms an important speciality, which is still in the hands of Yorkshire dyers, and the following particulars on the subject, abstracted from a lecture by such a practical dyer as Mr. James Sharp, of Bradford,* will give a good idea how the processes of dyeing and finishing are conducted.

In Yorkshire the machinery and mode of treatment differ entirely in several important particulars from those in use in Lancashire, and therefore any special aptitude which the Yorkshire dyers have acquired in the dyeing and finishing of cotton goods, and more particularly in that class known as "Italian cloths," is principally owing to the application of principles distinct from those in use in the Lancashire trade, and to the use of machinery capable of producing different results.

The drawings (figs. 1 and 2) represent a treble crabbing machine, by Messrs. Elkanah Hoyle and Sons, Limited, Halifax, which is not used in the Lancashire dyehouses, but is indispensable in the finishing of worsted and mixed goods, and which has some advantages in the finishing of cotton goods. Fig. 1 shows the front, and fig. 2 the end elevation.

* Before the Manchester Section of the Society of Chemical Industry in 1884.

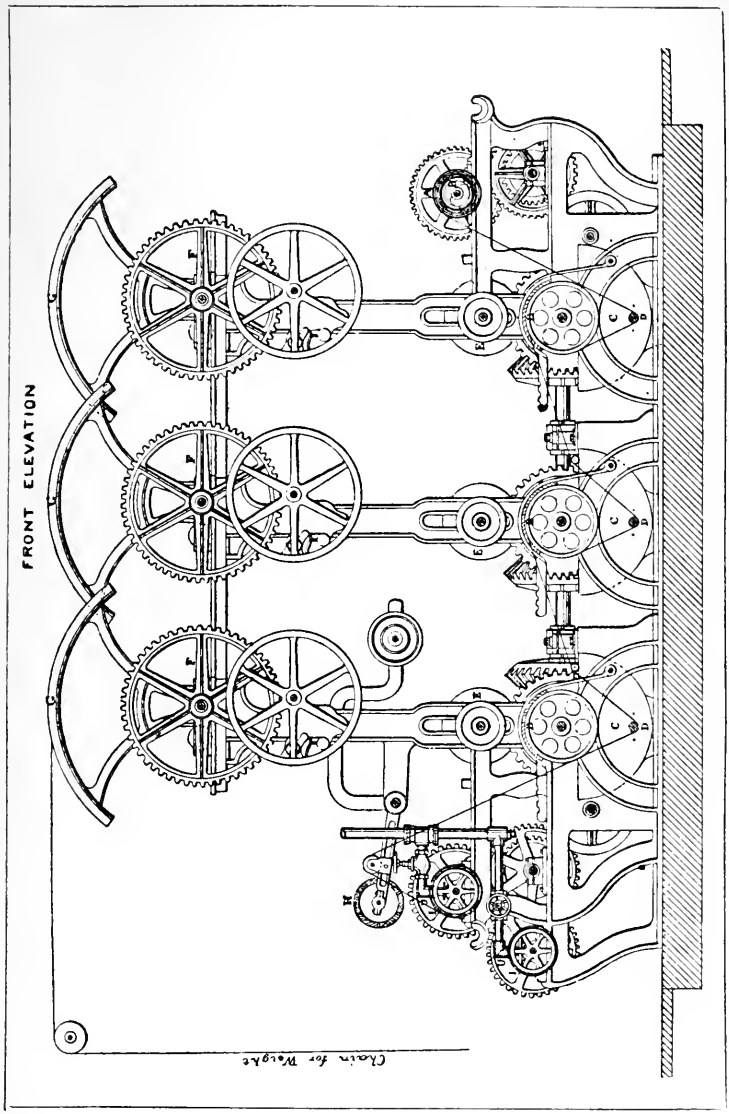

Fig. 1.

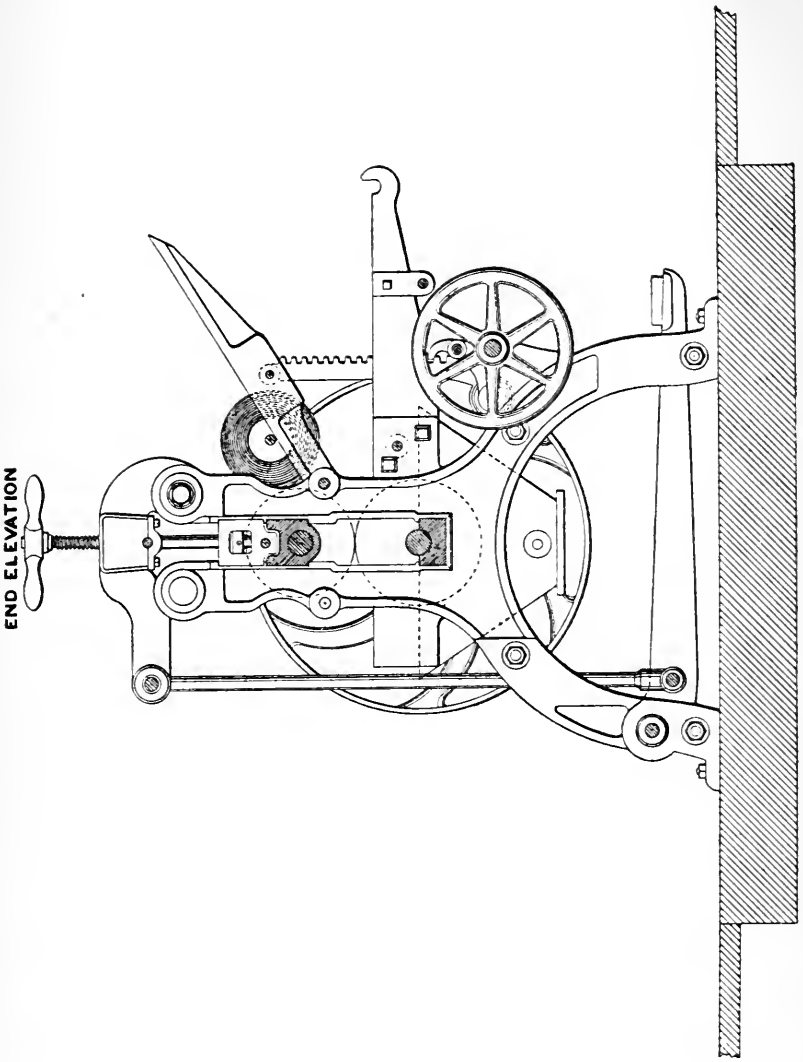

Fig. 2.

Simple as this crabbing machine may appear, it is by the skilful use of it in preparing, or as we term it, "gray-finishing," all the various kinds of goods, that the length is increased by two or three yards per piece, the gloss or lustre on alpaca goods produced, the smooth, close silky finish given to Italian cloths or other goods, also the soft cloth handle imparted to all-wool goods and cashmeres, and, what is more important, the finish put upon the goods by this machine is permanent, and withstands the action of the boiling dye-vat. The drawing represents a treble crabbing machine, each crab having separate motion or gearing. Practically these crabs are identical one with the other, and each crab has nine parts, used to produce the various finishes. These are marked alphabetically in the order in which they are used. A is the beaming or batching roller, B is the brake to put tension on the cloth, C is the trough for boiling alkaline solution, D is the roller in the trough to give increased tension, E is the iron squeezing or crab roller, F is the rack for raising or lowering the top roller, G the lever for putting pressure on the top roller, H the expanding roller to prevent creasing, and I the taking-out or rolling motion. To begin with, the workman causes about five pieces of worsted or cotton Italians to be stitched in one length, with wrappers to protect the outer ends. The batch of goods is taken from the singeing and laid in open fold, convenient for being wrapped or batched round the beaming roller A. This only places the goods in a convenient position for treatment on the first crab. The trough C is made ready with boiling alkaline solution, when the wrapper which is stitched to the end of the goods is threaded, in open width, through the boiling water under the small roller D, then wrapped round the bottom crab roller E, as shown in the drawing. The brake B is adjusted to give the proper tension to the goods, and the top crab roller E, which has hitherto been raised, is now lowered to bear upon the cloth, and when necessary additional pressure is put upon the cloth by the lever G. The crab is put in motion, and under these conditions the cloth is drawn or made to travel

from the beaming roller A through the boiling alkaline solution on to the bottom crab roller E. This process is repeated upon the goods as they are made to travel in like manner to the second and third crabs, after which they are taken on to rollers by the taking-out motion I. The expanding roller E, as already mentioned, is for the purpose of keeping the goods free from creases during the process of batching on to rollers. Worsted goods require to undergo other processes which are not necessary in the case of cotton goods. The steaming and reversing appliances attached to the crab, and marked J, are only applicable to the finishing of Bradford stuffs, and are the patent rights of Messrs. Elkanah Hoyle and Sons, Halifax. This crabbing machine is capable of preparing about twenty pieces per hour, or 200 pieces per day of 10 working hours. In treating cotton Italians with the crab in the same manner as real Italians, we obtain an increased length, a smooth, close, even surface, a softer or more cloth-like handle, and the condition of the goods is not only most suitable for dyeing black, but, what is of very great importance, the weight of the cloth is fully 10 per cent. heavier than that of similar goods which are prepared by kier bleaching. The object of the Yorkshire dyer is to maintain the size as far as possible, and we are of opinion that the process of crabbing is best calculated to maintain the original weight of the goods, and to produce increased length and improved handle.

The process of mordanting, as practised in Yorkshire, is performed by means of jiggers. The smaller one (fig. 3) represents the most improved jigger as used in the Lancashire dye-houses, and as far as regards size it is the same as was first used in Yorkshire. The larger drawing (fig. 4) represents the largest size used in Yorkshire dye-houses. A batch or charge for the small jigger is generally five pieces of 75yds. each, whilst a batch or charge for the large jigger, as worked in Yorkshire, is 40 pieces of 75yds. each, so that in preparing 40 pieces they employ in Lancashire eight jiggers with four men, whilst in Yorkshire 40 pieces are prepared on one large jigger with two men to attend to it. The goods, after

Side Elevation

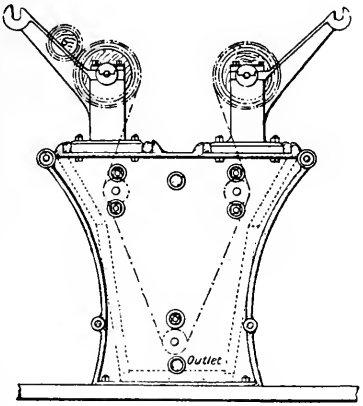

Fig. 3.

Side Elevation.

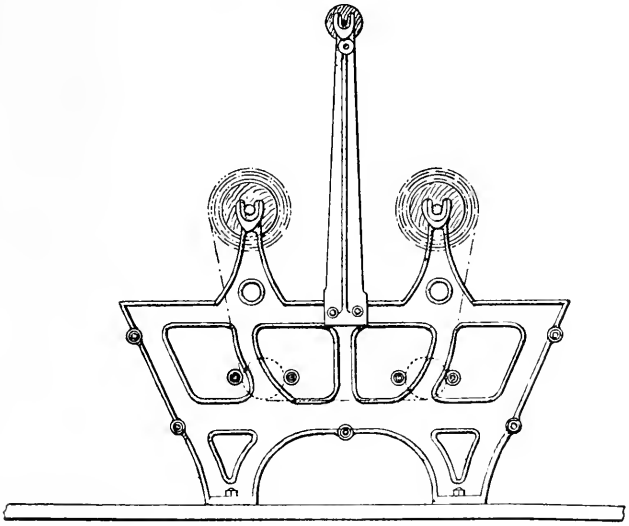

Fig. 4.

having been crabbed in the very way described, are brought on to these large jiggers, and the first process is to sumach or impregnate the cloth with any of the substances usually employed which are richest in tannin, after which the goods are saddened, as it is termed, as a rule with solutions of salts of iron. These processes produce a deep slate colour, inclining to black. After this the goods are taken into the dye-house, where the processes of dyeing are performed with boiling-hot solutions, in the very large dye-vats, which are represented in the drawings (figs. 5 and 6). These vats are made in two sizes. The smaller one is capable of dyeing 40 pieces, and the larger one 80 pieces at once. The drawings will give an idea of the working principle of the dyeing machines. These vessels are always worked in pairs In the first the goods are boiled in a solution of bichromate of potash or soda. This process causes the dye to unite firmly with the cloth, and gives a deeper shade of black. In the second vat the goods are dyed with logwood, and in some cases with the addition of fustic. The dye is fixed boiling hot, after which the goods are washed.

Now it is a fact that in the case of all cotton goods dyed black—no matter what may be the processes or materials employed—when they leave the dye-bath they are a red shade of black, which is afterwards corrected to the proper shade in various ways, and by the use of a variety of materials. In Lancashire, soluble oil is one of the articles much in favour. Whether the goods are bottomed with cutch, sumach, divi-divi, myrabolams, iron salts, copper salts, or by a judicious mixture of some of these, good blacks can be produced, but whilst in Lancashire the processes of preparing and dyeing black are generally done on small jiggers, where the dye is not fixed boiling hot, in Yorkshire the goods are dyed in the large vats represented in the drawings, after which they pass through the usual processes to condition them for finishing, which in Yorkshire is done by hot pressing. This process enables the workman to produce a watered effect on the back, and a satin finish on the face side of the goods. The Lancashire method is to

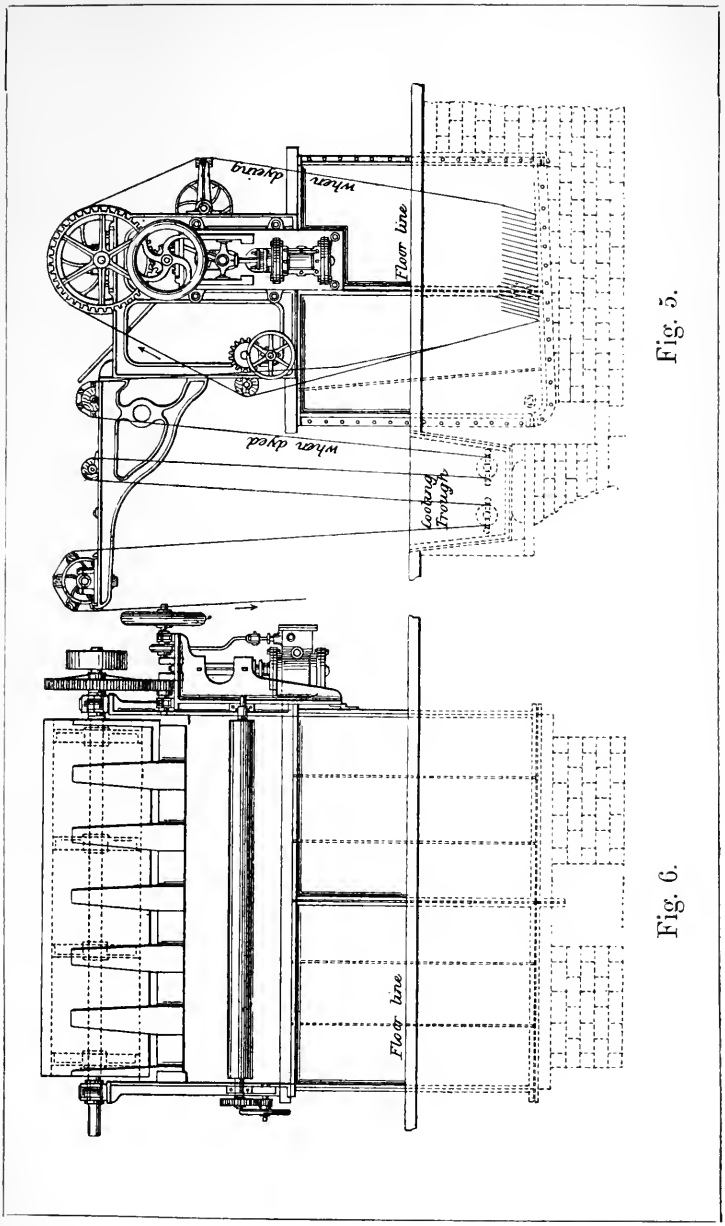

Fig. 6.

Fig. 5.

finish generally on calenders ; and excellent as is the finish produced in that way, it is distinct in every characteristic from that produced by the Yorkshire mode, whilst goods treated by the Lancashire method, in all the processes, feel thinner, handle more papery, and, if anyone spends a short time in cutting them up with shears, more especially in the case of coloured goods, he will find the cut is harsh, and gives the idea of dryness and a grating sensation. On the other hand, the Yorkshire dried goods feel more kind and clothy, and cut more freely.

There is another point connected with the dyeing of black cotton Italians which is of the greatest importance both to dyers and merchants. Some dyers rely almost exclusively, if not entirely, upon copper salts as their mordants. Now, although goods dyed upon such a mordant can be made to present a very satisfactory appearance for a short time, yet when such goods are shipped, as they have been, to distant Eastern markets, the consequences are most serious, for the combination between mordant and dye is a very feeble one in the case of such dyes, and logwood, with which all ordinary blacks are dyed, is not itself a fixed dye. Its permanency depends entirely on the application of proper mordants. Now, when copper mordants are relied upon, and more especially if in the last process the dyer uses alkalis or ammoniacal solutions, the copper salts, or otherwise the oxides of copper, continue to exercise an influence on the logwood and fustic (when present), until the black dye is changed into green olive. This is, of course, a great drawback, and has been a cause of great trouble to some dyers.

BROWNS

are mostly dyed by means of cutch or catechu, the colour being fixed with bichrome.

100lbs. Cotton.

1st.—Boil 20lbs. cutch in 100 to 150 galls. water, to which add 2lbs. copper sulphate. Enter cotton, work 20 to 30 minutes, leave in bath 2 hours, and then wring.

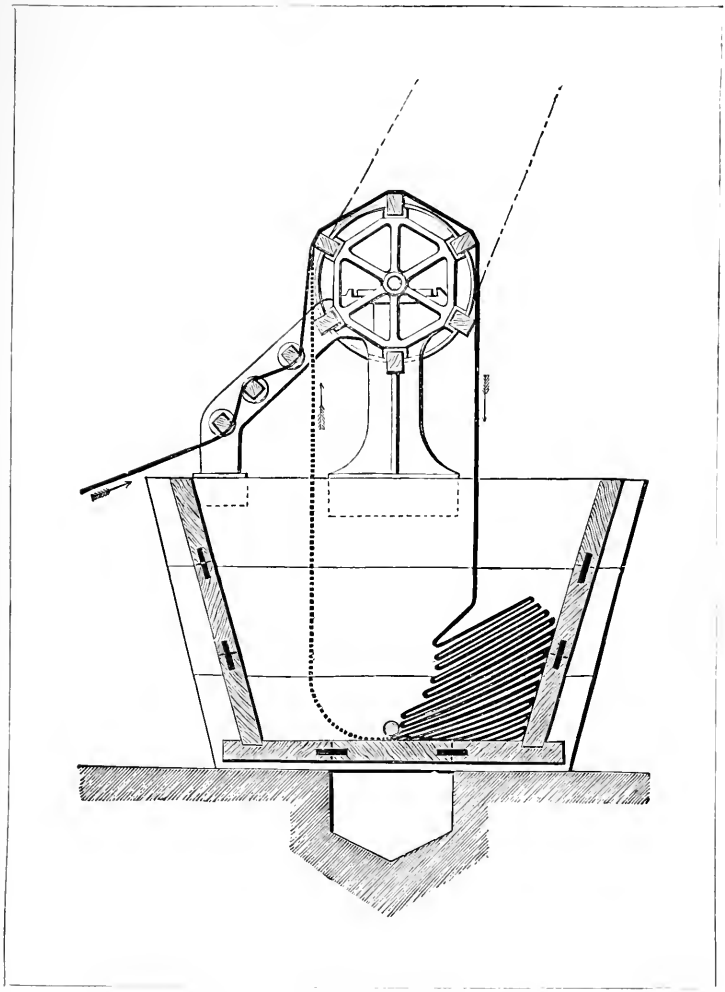

PLATE XVII.—JIG WINCH.

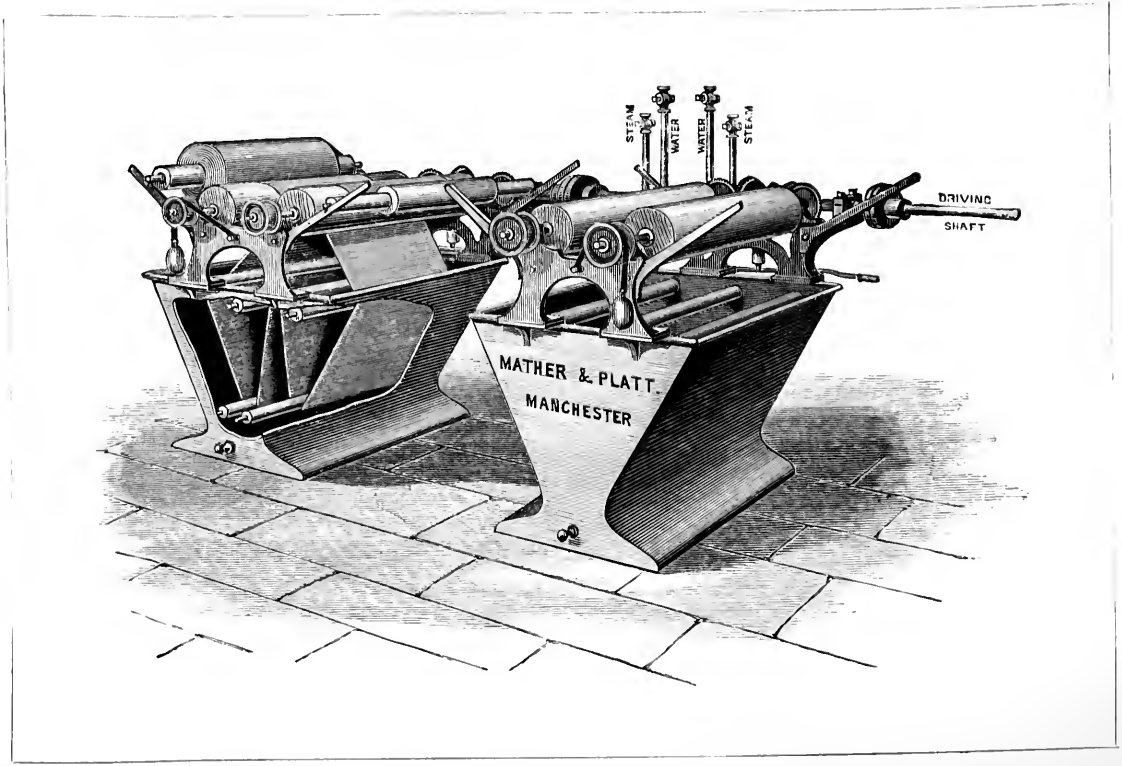

PLATE XVIII.—DYEING JIGGERS.

2nd.—Enter new boiling bath, prepared with 5lbs. bichrome. Work ½ hour and wash.

By adding logwood or other dyewoods to the first bath the shade can be greatly modified; also by altering the proportions, lighter shades can be produced, which are often topped with magenta or other aniline or dyewood.

Colours.—The shade may also be modified by passsing through an iron bath after dyeing, and dark browns almost to a black can thus be produced. In fact, blacks on cotton are also sometimes produced by giving them first a brown bottom with cutch and chrome.

YELLOWS.

Since the introduction of auramine, the dyewood yellows have to a certain extent fallen into the background; they are, however, still used, especially the shades produced with quercitron, its extracts, or flavine.

As a rule cotton mordanted with alumina will dye a yellow colour either with quercitron, fustic, or Persian berry extracts, and the yellow produced is all the better if the cloth has been oiled at the same time, as for alizarine red dyeing. This process of mordanting is, however, rather expensive, in fact, the method of mordanting with alumina, through acetate of alumina, is in all cases expensive and cumbrous, and is only resorted to when there is no help for it, which, of course, is not the case with yellows, which can now be so easily dyed, principally by means of auramine on cotton mordanted with tannic acid, and tin or antimony mordants.

Very often light shades of yellows, or so-called straw-colours, are dyed by means of fustic extract, and a small amount of alum in the dye-bath.

Turmeric yellows are even now produced on cotton, which is not mordanted, the dyeing being also simply effected in one bath by acidulating the colour solution by means of sulphuric acid.

Annatto is also pretty largely employed for fancy shades of salmon up to orange colours. For the purpose the dyestuff is simply dissolved in a soda lye, and the solution, after separating from the undissolved, is simply added to the dye-bath where the cotton is worked, according to the shade required. The colour is afterwards fixed or not, as the case may be, with weak sulphuric acid in a fresh bath.

Among the patterns will be found a yellow, dyed with flavine, for which the method will also be indicated, and consequently will not be described here.

It is sufficient to say that with quercitron or flavine, yellows can be produced of more or less deep shade by simply working in a bath containing the dyestuff solution, along with tin crystals, and raising the temperature gradually up to 80° C. Deeper shades will be obtained if the cotton has been previously mordanted with sumach or tin.

REDS.

For red dyeing on cotton the dyewoods and natural organic colouring matters generally are of very secondary importance. The numerous coal tar colours, especially alizarine and the azo scarlets and reds, have, to a great extent, driven them out from the dye-houses.

Barwood Reds are, however, still dyed, but in diminishing quantities, even since the scarlets with safranine and phosphine, and especially the scarlets of safranine and chrysoidine or auramine, were introduced, and the cheap new direct reds will also be very powerful competitors, not to mention alizarine reds, which are being dyed so cheaply now-a-days. Barwood red is dyed on cotton mordanted with sumach and stannic mordants.

Peachwood Reds have little or no importance, and *Cochineal* also is very little employed.

Safflower pinks, however, are still dyed, in spite of the competition of the eosines, on account of the peculiar shade they produce.

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OTHER FANCY SHADES.

A large number of fancy shades are produced with dyewoods, such as:—

Greys by passing the cotton—1st, in sumach solution, and then in iron liquors or copperas solution. Logwood or cutch if taken instead of sumach produces other shades of grey, which may be further modified by the employment of copper sulphate or bichrome for the second bath.

Olives of great variety of shade can be produced, for instance, by means of quercitron and logwood, such as:—

Olives—No. 1.

1st.—Mordant in sumach over-night; wring.

2nd.—Through iron solution dyed to a grey, wash, &c.

3rd.—Dye in new bath with bark extract, to which add 5 to 10 per cent. alum to weight of cotton, and at the end logwood extract solution, according to the shade required.

2nd method.

Boil cotton in mixture of fustic and logwood solutions, then add copper sulphate in same bath, work to shade, wash, and finish.

3rd method. 100lbs. cotton.

1st.—Prepare boiling bath with—

5 to 7½lbs. cutch;

enter yarn, give 6 turns, lift.

2nd.—Add in same bath—

3 to 4lbs. copperas;

give 5 turns, lift, leave 2 hours on sticks.

3rd.—New bath with—

2½ to 5lbs. fustic extract;
1 to 2lbs. copper sulphate;

bring up to boil; after 9 turns, wash and dry.

Of other dyewood colours produced, the blues, with logwood, have now no interest for cotton dyeing, except for the purpose of topping indigo dyed goods, as dark blues

are seldom, if at all, produced on cotton with logwood alone by adding copper sulphate and alum to the dyebath.

INDIGO BLUES.

Indigo blues still form a very important branch of cotton dyeing, and the preparation of the vats has not been the subject of any real improvements since the introduction of the hydrosulphite method of Schützemberger and De Lalande. A recent proposal has been for the fermentation vat by a known quantity of glucose and sugar; in other words, the old fermentation vat under a more scientific management, and with materials which can easily be kept under control. So far, however, the other methods are still employed.

The Copperas Vat is still largely employed among the cotton dyers, and gives very good results when well conducted; it has, however, the drawback of forming a large proportion of sediment, and consequently requires not only very deep vats, but also a certain time for settling after it has been agitated, otherwise it will be too muddy and will not work well on the yarn.

The proportions employed vary very considerably in the different works, and depend, not only upon the quality of the indigo, which, as is well known, varies very greatly in strength and price; but also upon the kind of work and depth of shade required.

The conduct of the vats, and indigo dyeing generally, cannot be taught by recipes or directions in books, but has to be learned practically by experience in the works; since, although the theory of the reduction of the indigo blue into indigo white appears very simple, the practice on a working scale is of much greater difficulty, since there it is only a question of making the dyeing pay, or not pay, according to the ability of the dyer.

By referring to books on dyeing, and also to the experience of practical men, it will be found that the proportions of indigo, lime, and copperas vary considerably according

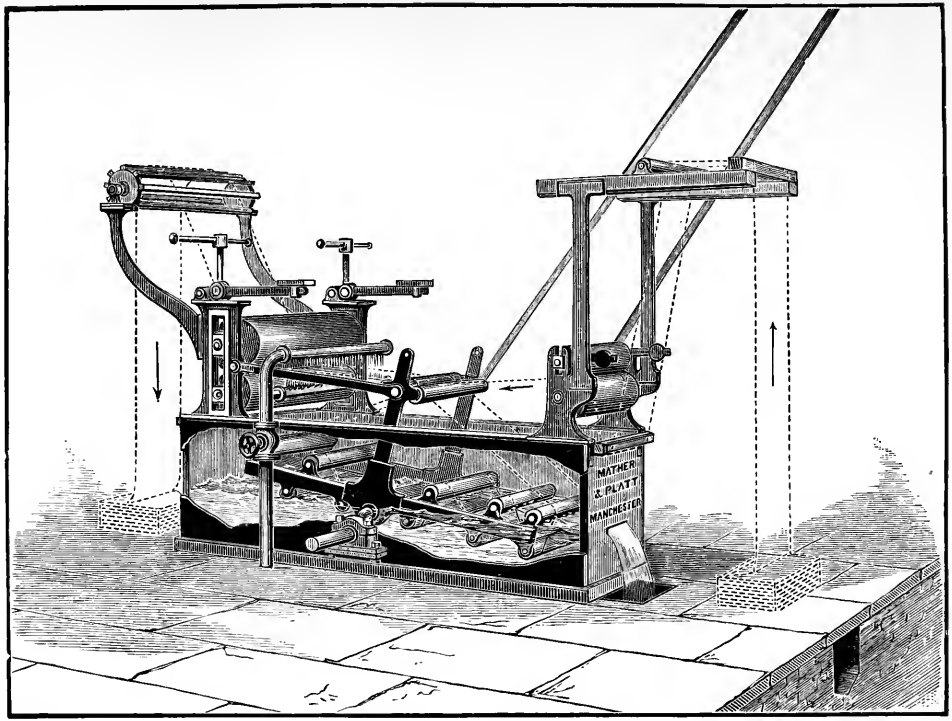

PLATE XX.—OPEN WASHING MACHINE.

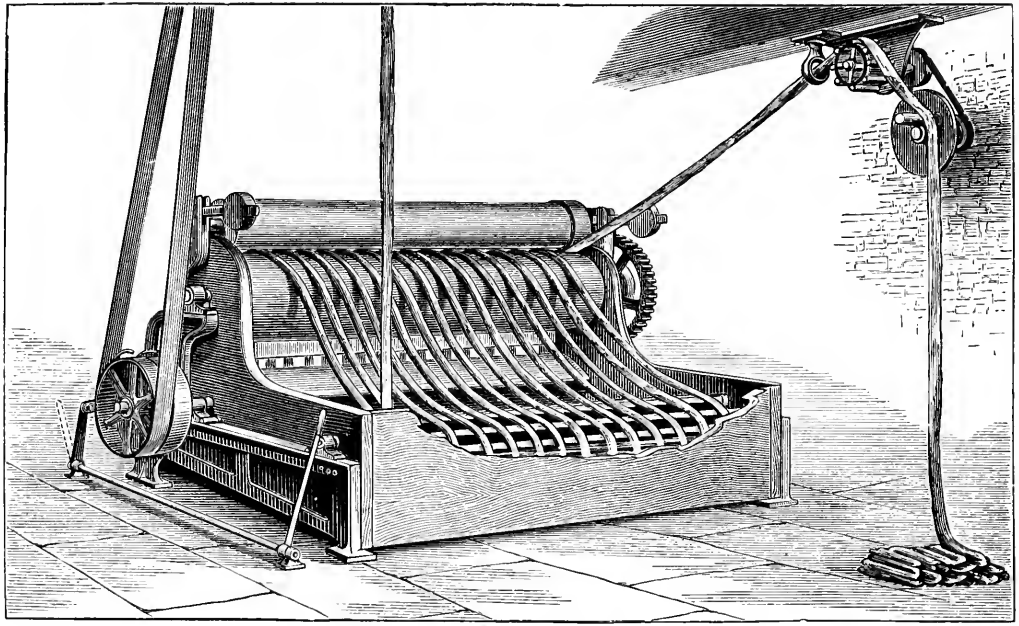

PLATE XXI.—CLOTH WASHING MACHINE.

to different authors or practical dyers; the fact is that an excess of the reducing power must be at hand, and this excess if too great will help to swell the volume of the sediment at the bottom of the vat. On the other hand, too small an amount of either lime or copperas will also act injuriously by not utilising all the colouring power of the indigo.

The following proportions may be taken as an example:

Copperas Vat.

10 grs. indigo, finely pulverised	1lb.
15 to 20 grs. copperas.....	$1\frac{1}{2}$ to 2lbs.
25 to 30 grs. burnt lime	$2\frac{1}{2}$ to 3lbs.
1 litre water.....	10 galls.

The indigo is perfectly ground to impalpable pulp in a wet mill, and added to the vat. The copperas is then added after having been previously dissolved in hot water, and left to cool. Finally, the lime, which has been slacked with water, and made into a thin milk, is added, and the whole well raked up with a wooden rake. Some dyers leave the reduction in the vat to act for twenty-four hours before they use it, and keep raking it every four hours during this time before they begin the dyeing. As a rule several vats are worked at the same time, and the goods are dipped first in the one and then in the other, until the desired shade is produced. After every dip the yarn is wrung by taking good care that the liquor falls back again into the vat. The yarn is then allowed to lie, when the change of colour or the greening will be soon apparent. The skill of the indigo dyer is shown, not only in the setting up of the vat, but in the working of the sets of vats, which he generally keeps going, and which he manipulates in such a way that he exhausts them one after another, while keeping the rest sufficiently strong to go on with the work without interruption.

The Zinc or Composition Vat.—The zinc vat is prepared with zinc dust, a by-product in the zinc manufacture,

which is now in successful employment in indigo dyeing. This zinc dust is also called composition or preparation. The advantages of this vat over the other with copperas is that it does not form so much sediment, and this is besides not so light and slimy as the iron oxide, and consequently settles more quickly, and more work can be had out of the same vat, which lasts longer, because the sediment does not accumulate so quickly, and less indigo is wasted by being carried with the sediment. The proportion also in this case varies considerably, and the preparation of this vat is sometimes so effected that a strong vat is first formed, which is then added to water in another vat, according to the shade required.

The following proportions may be taken as an example for the preparation of a

Zinc Vat:

10 grs. finely ground indigo..... ...	1lb.
5 grs. preparation	½lb.
10 grs. burnt lime.....	1lb.
2 to 3 litres water.....	20 to 30 galls.

The reduction takes place in from 12 to 18 hours, when the vat, which has become in turns greyish blue, green, and yellowish green, turns a pure yellow. To remove the froth, which is caused by the evolution of hydrogen, an occasional good stirring and raking is necessary. As a rule, in one hour the vat is sufficiently settled to allow the cotton to be dyed. Too much frothing in this vat is caused by too much composition having been used, and this can be prevented by removing some of the composition from the bottom after settling very carefully with a shovel, arranged at right angles at the end of a long pole, which is carefully immersed down to the bottom of the vat. A muddy vat is also set right by stirring and allowing to settle.

From the practical experience of several dyers, it may here be mentioned that with a fair quality of indigo, according to a friendly communication obtained from

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Messrs. Schloesser, who kindly supplied information and material to the author for his pupils' experiments while at the School of Dyeing, it appears that about the following proportions have been found to answer well in practice:—

A piece dyer takes for—

About 40 to 50lbs. indigo.
24lbs. preparation.
56lbs. slacked lime.

Another piece dyer takes—

About 60 to 65lbs. indigo.
34lbs. preparation.
23lbs. lime.
17lbs. iron borings.

A yarn dyer takes—

About 3 to 5lbs. indigo.
1lb. preparation.
2lbs. lime.

The Hydrosulphite Vat.—The following particulars the author owes to the kindness of Messrs. Read, Halliday and Son, to whom he is indebted for the indigo blue yarn and loose cotton, also kindly supplied by them; likewise for more than one visit to their extensive works at Huddersfield, where he was kindly shown both the plant for the preparations of the Schützemberger's and De Lalande's vat, and the practical manipulations and apparatus for dyeing loose cotton and wool.

To set a vat, say 6 feet square by 7 feet deep:—

Fill with clean water.
Take 78lbs. bisulphite of soda,

Mix in a zinc or galvanised iron pail for ten minutes with

6lbs. zinc preparation,

and add this mixture to the vat; then add

6lbs. dry slacked lime,

and indigo solution sufficient for shade required.*

Cotton is dyed cold in this vat, and it is advisable to be rather on the lime side, that is, even to increase the above

* The indigo solution is specially prepared by this firm on purpose for this vat, and practical dyers are generally sent to show the method of employment.

proportion of lime if it should be found necessary. The vat should feel soft and slippery.

To replenish the vat, for every 100lbs. of goods to be dyed, add—

10lbs. bisulphite of soda,

previously mixed for ten minutes with

13oz. zinc preparation,

then add—

½lb. slacked lime,

and indigo solution to shade.

Grinding of Indigo.—Indigo is often ground dry, but in many cases it is ground on the wet mill also, with a small amount of water, and this wet grinding is to be recommended. The indigo mills either for dry or wet grinding have been so often described that it is unnecessary to give any description here. It is of great importance that the dyestuff should be reduced to very fine powder, in fact, to impalpable pulp, before it is added to the vat, otherwise loss of colouring matter will result.

Some dyers effect even the reduction to indigo white on the mill, and then add the reduced indigo to the vat. Indigo-dyed yarn, after greening, is generally passed through a weak sulphuric acid bath, at 1 to 2° Tw., with or without alum, well washed and dried; the lime is removed, and the yarn thus cleansed.

Topping Indigoes.—Indigo being an expensive dyestuff, it has been at all times sought to reduce the cost by topping indigo-dyed goods with cheaper colours, such as with logwood, methyl violet, &c.

Methyl violet has been pretty largely employed for the purpose in the last few years, since it imparts to indigo on yarn or cloth a redder and brighter shade, and gives to it the appearance of a darker blue. As may easily be supposed it is not fast, as in the majority of cases the indigo-dyed yarn is simply passed through a bath containing the violet solution, and dried without any further process. The violet is seldom fastened on the cotton by previous mordanting, with sumach and antimony or tin mordant.

Topping with logwood is also very largely practised, and, like the other, it is simply a sophistication, since the top colour does not possess the solidity of the indigo bottom. This topping with logwood is performed by passing the goods, after having been dyed in the vat, and soured and washed, through a new bath with the necessary amount of logwood, to which copper sulphate has been added.

In the last few years a special logwood preparation (indigo substitute) has been introduced in practice for topping indigoes, and answers fairly well for many purposes.

Bottoming Indigoes.—Indigo-dyed goods, either yarn or cloth, often receive a bottom of cutch brown on Cachou de Laval,* over which the goods are then dyed in the usual way. Aniline black, or rather a greyish blue with aniline, by the aniline black process, is produced on cotton yarn, and then dyed in the vat; but the black bottom, by undergoing reduction in the vat loses a great deal of its former fastness.

Indigo Mordants.—Under this name preparations have been sold for years, which are stated to accelerate the dyeing of indigo on cotton, since they reduce the number of dips required. In many instances this saving is more apparent than real, while in many cases these so-called mordants are of no utility whatever. As a rule manganese salts have been employed for the purpose.

The preparation of the vat by the electrical current is too costly and complicated to be at present of any practical utility. The old vat for fermentation of the indigo in connection with woad, bran, and madder is still employed for cotton yarn dyeing in the older countries, and apparently with good results, and the yarn, after dyeing, is not even washed, but simply shaken from hanging dust, and this is possible in this case, since no lime is employed in the preparation of the vat, but the potash lye produced by the lixiviation of wood ashes. Very cheap dyeings are produced

* Cachou de Laval.—Under this name a product is employed in cotton dyeing, which yields shades resembling to a certain extent those produced with cutch; they are fast against light and soap, and cheap, but not very bright. Cachou de Laval dyes cotton without mordant, but can be fixed by means of copperas or bichrome bath.

by this method, and the author has seen very good results obtained by means of this vat by dyers in South Italy. It is also stated by some authorities that indigo blues, dyed in the fermentation vat, are faster than those produced by the dyeing in the vats with metallic reducers.

It will be interesting before concluding this notice on indigo dyeing, to mention the following practical method of

Indigo Testing:—

1 gr. indigo; powder very finely in mortar; first dry, then with very little water, enough to make paste. When fine enough, add 2 grs. zinc powder, then 10cc. bisulphite of soda solution 50°. Mix well for five or six minutes, then add 2 grs. caustic soda; stir well. The indigo will at once be reduced; add water to fill the mortar, and mix well; then pour the whole into an earthenware jar, and wash mortar with water, pouring the liquor into the jar. Make up to 1 litre. Dye in this bath, with 40 to 50 grs. cotton, either yarn or cloth.

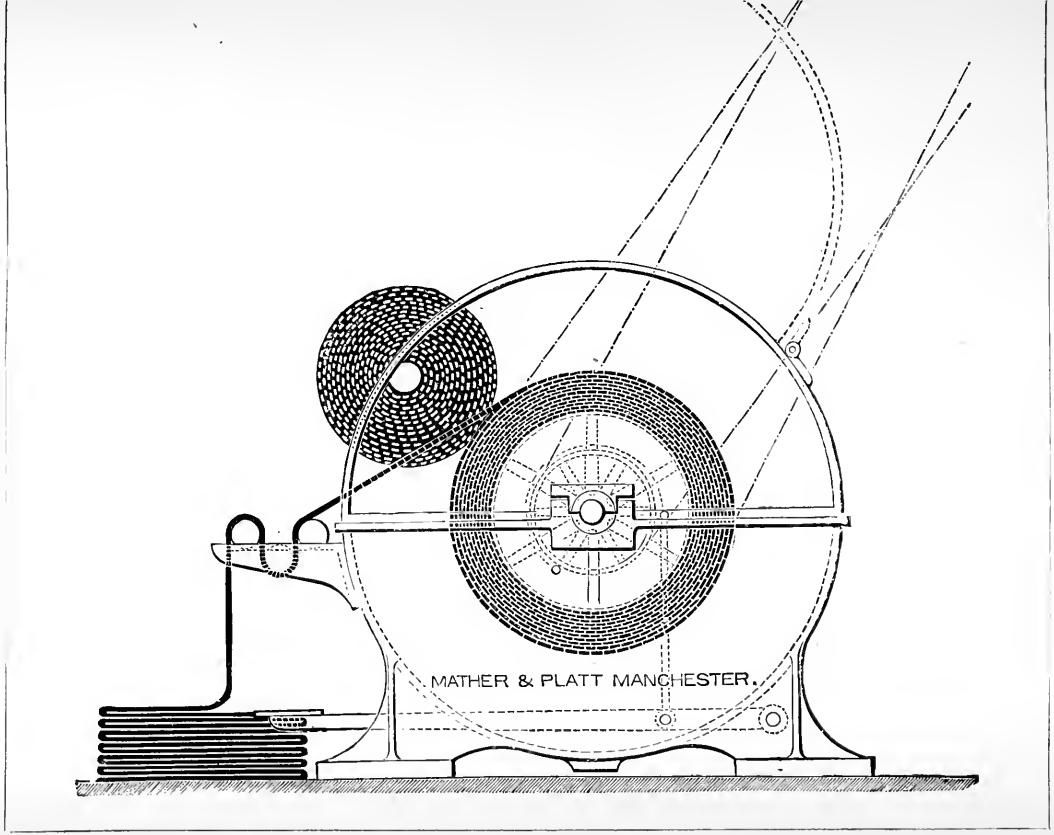


PLATE XXIII.—HYDRO EXTRACTOR.

LINEN JUTE, CHINA GRASS, &c.

CHAPTER VI.

LINEN.

PARSY'S NEW RETTING PROCESS.

THIS method consists in the treatment of the dried flax stems in a closed kier under pressure, by means of water and steam, and the following particulars, from an article by Renouard, in the *Industrie Textile*, will be found interesting. The apparatus employed is shown in Fig. 7.

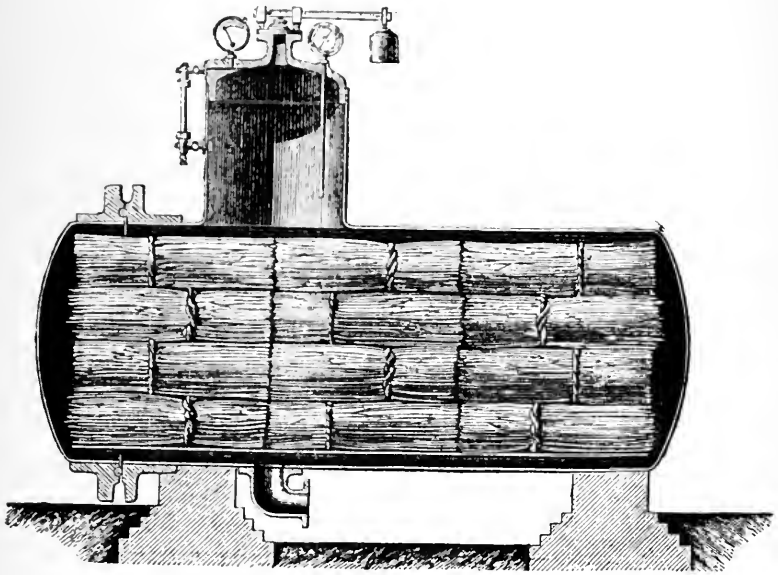


Fig. 7.

It is a horizontal boiler strongly constructed, is capable of standing heavy pressure, and is supplied with gauge and safety valves, &c. The front of the kier may be taken out and closed up at will by means of the stout cover, which is constructed for the purpose, and which can be unbolted and lifted up when the apparatus has to be charged or emptied. The flax straw is simply placed in a wagon or carriage, which fits closely into the boiler, and which can easily be taken in and out. The apparatus, it will be seen, resembles in construction the Mather steamer kier (described in the bleaching process section of the author's book on "Printing"); but in the present case artificial circulation is caused to take place. The bottom of the kier is supplied with a discharge pipe for letting out the spent liquor.

The operation is started by opening up the cover, which is held by hinges at the top end; the carriage, laden with flax stems, is introduced, and the apparatus closed up again by bolting the cover to the kier. Boiling water is then introduced. This water consists of the liquor of a preceding operation, to which one-third of fresh water had been added. This point is of importance, since pure water would deprive the retted flax of its brilliancy and softness; but by employing this water over again, M. Parsy succeeds in preserving to the fibre that brilliancy and feel which it would otherwise lose during the operation. Another precaution is also necessary, which is to allow the air to get out of the apparatus when the water is introduced, and this is easily accomplished by a suitable pipe arranged at the top of the apparatus from which the air and steam are driven out, and which is afterwards closed. The flax is exposed in the kier for half an hour to the action of the water, the pressure being so arranged that it corresponds to a temperature of 125°. After this the liquor is let out, and steam at five atmospheres is introduced, and allowed to react for one hour. The kier is then opened by lifting up the front cover, and the carriage is let out. It will be found that the stems so treated have already lost one-quarter of their original

volume. Each carriage is constructed to contain 400 kilos of flax stems, and in twelve hours 2,400 kilos of stems may be treated by this method in one kier, giving about two tons of retted product.

The drying of the stems, which has always been a difficulty with the retting of flax, is performed by an arranged apparatus, also devised by M. Parsy, as shown in Fig 8. The stems, after having been taken out of the

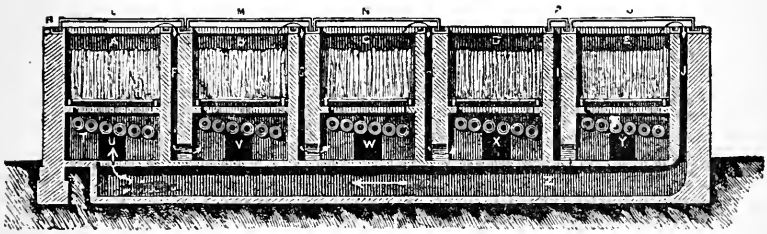


Fig. 8.

carriage, are opened up and separated from each other, and then placed in a vertical position in the drying apparatus. This is composed of a series of chambers—A, B, C, D, E, communicating with each other by means of the open space—F, G, H, I, J. The chambers are covered by means of wooden covers—P, M, N, P, nine of which are laid on troughs filled with sand, and thus form a convenient covering, which can be easily removed. The flax, as seen in the figure, is placed in the chambers on a suitable stand, and under this stand is a series of pipes for the heating of the chamber. The last flue, J, communicates with the chambers by the flue Z; and the dampers, U, V, W, X, Y, allow the communication between the flue and the chambers to be closed or opened at will.

By means of a ventilator, air can be blown into the chambers through a flue, and the communication can also be opened or closed by the dampers, U, V, W, X, Y. The work is proceeded with as follows:—Air is first blown into the chamber E, and passing through the flue J, into the

flue Z, penetrates into the chamber A by U, and, after having got heated by passing through the range of heating pipes T, ascends through the flax, and then through the flue F, into the other chambers, as shown by the direction of the arrow, and it finally goes out of the chamber D, the cover of which has been purposely removed. When the material in the chamber E is dry, it is removed, and the chamber is again charged with new flax, and the cover left open, while chamber D is covered up, and the air is blown this time through A first, going out by E. The apparatus is thus kept continuously working, each chamber being emptied and filled in its turn. The dry stems are now scutched in the usual way, or preferably by Cardon's machine, which effects the scutching and the combing at the same time.

In regard to the theory of this new method, M. Parsy states that the process depends upon the conversion of the insoluble pectose into the partially soluble pectine or pectic acid, by the action of the high temperature of the water, and that even a further conversion of the pectic into the metapectic acid takes place by the subsequent action of the steam, the metapectic acid being very soluble in hot water. The object of employing steam instead of water, in the second part of the operation, is to prevent the removal of too much of the pectose, as pectic and metapectic acid, which would impoverish the fibre, and deprive it of brilliancy and feel.

When properly retted, flax only loses 25 per cent. by the process, as by an ordinary retting. The water, after coming out of the boiler, only contains $1\frac{1}{2}$ parts its own weight of water, and, therefore, does not offer so much difficulty as the product of the ordinary retting.

LINEN BLEACHING.

As before observed, the fibre of flax is more sensitive against re-agents, such as bleaching liquor, &c., than is cotton, and consequently the same process which is employed for cotton cannot be employed for linen goods. Great care

must be taken in treating linen with chlorine liquors, otherwise the fibre may easily be damaged, and in some cases be completely rottened.

The processes of linen bleaching are also more complicated and tedious than those generally employed for cotton, and, in the majority of cases, the goods are even exposed to the action of the atmosphere by the so-called "grassing," by spreading them on the grass in the fields. This exposure in the fields is still carried on to a great extent in localities where flax is bleached. The old process consisted mainly in this, that the goods were boiled with lyes of ashes, well rinsed, and exposed on grass for several weeks, the boiling and grassing being repeated until the flax was completely bleached.

Modern processes effect the bleaching by means of chlorine, or rather chlorine liquor. The hypochlorites, as a rule, are used, chloride of lime being employed, while other hypochlorites, especially the magnesia and soda salts, are used with advantage, in this latter case dispensing altogether with grassing.

Linen Yarn. 100lbs.

1st.—Boil with 8 to 10lbs. soda ash, or 5 to 6lbs. caustic soda, for 3 to 6 hours, in low-pressure kiers.

2nd.—Expose to action of bleaching liquor $\frac{1}{2}$° Tw. for 1 hour, by working on sticks in ordinary dyebecks or on reels; then wash.

3rd.—Give acid bath in sulphuric acid 1° Tw., and after working until yarns are thoroughly imbibed, immerse in bath for 1 hour; then take out and wash.

4th.—Boil second time in kier, with 3 to 4 per cent. carbonate of soda, or 2lbs. NaOH.; wash.

5th.—Treat again with bleaching liquor and wash.

6th.—Pass through acid at 1° Tw., as mentioned before; wash well.

A half bleach only is obtained by this method, while, if a thorough bleaching be required, the yarns are exposed

again two or three times to the same processes until perfectly white. As a rule, after the third boiling with alkalies, the yarns are exposed in the fields for a week, and then submitted to the other operations.

The apparatus employed does not differ very much in principle from that used for cotton. The kiers are either the same or of similar construction, and in many cases stone cisterns are employed, or vacuum apparatus is used, in which a circulation is effected in the same way as for cotton yarn.

In some cases, for the treatment with bleaching liquors and acid, special arrangements are devised, the yarns being suspended on reels, which allow the same to revolve, while the hanks are only immersed at their lower ends in the bleaching liquor contained in shallow stone or wood vessels, and thus, after working with liquor, are exposed to the action of the air.

Many have been the methods and processes recommended for the bleaching of flax, such as, for instance, the employment of permanganate of potash, followed by a further treatment with sulphurous acid or bisulphite, in order to remove the brown manganese compound formed on the fibre; but these methods are too expensive, although they might give good results. As in the case of cotton, nothing has been found so effective, and at the same time so cheap, as the chlorine compounds.

BLEACHING LINEN CLOTH.

In spite of repeated trials and efforts, the bleaching of linen goods, either yarn or cloth, and especially the latter, is not much shorter now than was the case twenty years ago. Of course, linen might be bleached in much less time than formerly, but it would be at the expense of the strength of the fibre, which is considerably affected by severe treatment with the hypochlorites.

In fact, it may even be doubted whether the majority of bleached linen goods, of the present day, although of a

nicer appearance than those which were the pride of our fathers, possess the same solidity, and especially the same durability. It may be said that the whiteness of the modern linen goods is gained at the expense of their durability, as the fibre is more or less injured. For linen bleaching, generally the hypochlorites of soda or magnesia are preferable to the lime salt, as they are not so severe in their action.

The following process will give an idea of the operations which are now still followed:—

Bleaching Linen Cloth. For every 100lbs. cloth.

1st.—Boil with 8 to 10lbs. lime for 12 to 14 hours; wash.

2nd.—Hydrochloric acid bath $2\frac{1}{2}°$ Tw.; leave in cistern for six hours; wash.

3rd.—Boil 10 hours with resin soap, prepared with

2lbs. dry caustic soda,
2lbs. resin,

previously boiled together with the necessary amount of water for dissolving. After running off, there follows another boiling with 1lb. caustic soda for 7 hours; wash.

4th.—Expose in the fields for about one week.

5th.—Bleaching powder liquor, $\frac{1}{2}°$ Tw., 5 hours; wash.

6th.—Acid bath 1°, 2 hours; wash.

7th.—Boil for 5 hours with $\frac{1}{2}$ to $\frac{3}{4}$lbs. caustic soda; wash.

8th.—Expose in the fields for 4 to 5 days.

9th.—Bleaching liquor $\frac{1}{4}°$ Tw., 5 days; wash.

10th.—Rub with soft soap.

11th.—Expose in the fields.

Following, if necessary, by another bleaching bath, a souring, and final wash.

All these operations are performed on apparatus similar to those employed for the bleaching of cotton goods.

BLEACHING OF HEMP.

Hemp is seldom employed for the production of fine goods, and consequently it is very rarely bleached, but it

can be effected by following a similar treatment to that of flax.

JUTE.

BLEACHING METHOD.

1st.—Scour goods at 70° C, with a weak solution of silicate of soda, containing about 0·5 per cent. silicate. Wash.

2nd.—Pass through bleaching solution, consisting of sodium hypochlorite, obtained by treating bleaching powder liquor with necessary amount of carbonate of soda. This liquor must not contain more than 0·7 to 1 per cent. of available chlorine (corresponding to about 2lbs. bleaching powder per 10 gallons water). Wash well.

3rd.—Acid bath, consisting of hydrochloric acid, at ½ to 1° Tw., containing a small amount of sulphuric acid. Wash well.

Goods so treated have a pale cream-white colour, and are of soft and lustrous appearance, and they can be dyed at once, but, if intended for printing, they must still be treated as follows:

4th.—Work in a bisulphite of soda bath, containing 1 to 2 per cent. sulphurous acid, and then immerse in same bath for 2 to 3 hours; then squeeze out the excess of liquor, and dry on cylinder.

By this operation sulphurous acid is driven off, and the goods are impregnated with sulphite of sodium, which prevents any oxydizing action on the fibre during the process of steaming. The goods are also considerably whitened by this means.

Jute cloth so treated loses 7 to 8 per cent. of its weight.

The following recipe is taken from the "Teinturier Pratique":—

White on Jute—100lbs.

Work three times in bath heated to 65° C. with
8lbs. hydrochloric acid,
and leave one hour in a cold bath prepared with
20lbs. chloride of lime.

Wring, and give two turns in fresh bath with

10lbs. muriatic acid,

so that the goods remain half an hour in this bath, then rinse. For a purer white, re-enter in a new chloride of lime bath, prepared with

20lbs. bleaching powder,

and follow with a second acid bath; rinse, and give the blueing or tinting, if necessary. In bleaching jute, it is advisable not to give the blue in connection with alkalies, because the goods thus acquire a brownish tint. The best plan is to begin at once with the bleaching, which is done by suspending the goods in a room in which the chlorine gas is allowed to circulate.

It is almost impossible to obtain a perfect white on jute without tendering the fibre considerably; in fact, it is difficult to obtain a good white at all.

CHINA GRASS.

BLEACHING.

The bleaching of this fibre stands between the two processes for the bleaching of cotton and that of flax. It is more readily bleached than flax, with which it shares, to a certain extent, the sensitiveness against hypochlorites, and, consequently, care must be taken in this respect, and the hypochlorites of soda on magnesia had better be employed, or if the lime salt is used diluted, liquors must be employed.

The boiling is preferably performed with caustic soda, and an ordinary process of cotton bleaching may be followed, with the difference that greater care is exercised in the employment of bleaching liquors, which are taken weaker, and used more repeatedly than is the case with cotton.

DYEING OF LINEN, JUTE, &c.

Linen goods are dyed by almost the same methods as those followed for the dyeing of cotton. Linen and all

bark or bast fibres do not take the dyes as readily as cotton, and the colours do not penetrate so well into the inside. Linen goods, however, are mostly sold in the bleached form as damasks and other goods, for which no other fibre can be substituted; but cotton has undoubtedly the advantage over linen for the majority of dyed goods. Indigo is largely dyed on linen, yarn, and cloth, principally in France, where it enters so largely in the clothing of the peasantry and working classes.

I shall give here only a few examples of the dyeing of linen and jute goods. The dyeing of jute has been greatly developed in the last few years, but it does not keep the colours well, and they are apt to fade very readily, especially those of the aniline class. Jute contains, to begin with, a certain amount of tannin, and consequently all the basic dyestuffs are generally dyed without the aid of any mordant. A collection of jute-dyed patterns will be found at the end of this work among the pattern sheets, where also the linen and china grass fibre will be found duly illustrated.

Black.

For 100lbs. Linen Yarn.

Boiling infusion of 80lbs. to 100lbs. logwood, or corresponding amount of extract.

4lbs. sulphate of copper.
4lbs. soda ash.

When cooled to about 180° F., enter yarn. Work for 20 to 30 minutes, lift out, wring; leave on heap a few hours, and wash.

Instead of soda ash, ammonia can be used in such a proportion that the precipitated hydrate of copper is re-dissolved. The bath in this case is used cold or hot, and the yarn after working in this bath is wrung out, and hung in a cool place to allow the ammonia to evaporate and fix the black on the fibre. This method may also be used for cotton, and can be followed by an iron bath.

Chome Blacks

are produced in the same way as with cottons, and so are

Sumach and Iron Blacks.

The following recipes for linen, jute, and manilla hemp may be taken as illustrations:

Bright Red on Linen Goods—100lbs.

Bleach goods as follows: 1st. Boil five hours with

5lbs. soda ash,
1lb. lime;

rinse, then pass through cold baths containing

5lbs. hydrochloric acid,

and rinse again.

2nd. Dissolve

5lbs. chloride of lime

in water, leave to settle, pour off clear solution, in which immerse the goods for six or seven hours; lift out and wash. Pass through hydrochloric acid at ¾ to 1° F., and wash well

Mordant with

5lbs. to 10lbs. tannic acid

in boiling bath, wring and dye with

1lb. safranine yellow shade

in new bath at 170° F.

Greenish Mode on Linen Goods—100lbs.

Mordant for one hour in

20lbs. sumach,
4lbs. solid fustic extract.

Wring and enter new bath, containing

20lbs. copperas.

Dye in new bath at 170° F. with

2lbs. dry fustic extract,
5lbs. alum,

and either indigo, carmine or magenta solution, according to shade required.

Blueish Mode.

Mordant with sumach and copperas, and dye up to shade with alum, indigo, carmine, and magenta.

Reddish Mode on Linen Goods—100lbs.

Work at 150° F. in solution of

4lbs. prepared cutch,

for one hour; wring. Enter in new bath at 180° F. with

2lbs. bichromate of potash.

Rinse and dye in fresh bath, with alum, indigo, carmine and magenta.

Yellowish Ecru on Linen Yarn—100lbs.

Boil half hour in bath, with

5lbs. soda ash.

Work one hour at 140° F. in bath prepared with

¾lb. yellow catechu.

¾lb. quercitron extract.

Lift out of bath, to which add

1lb. nitrate of iron at 50° Bé.

Re-enter goods; work half hour; rinse in cold water. Dye in new bath at 120° F., with

2½lbs. alum

and the necessary amount of Bismarck brown, phosphine, and a few drops of a solution of quercitron and logwood extract. Wash, wring, or whiz and dry.

Olive on Jute—100lbs.

Work in bath, prepared with

1lb. fustic extract.

15lbs. sumach.

When well impregnated, lay down for three hours. Lift out, leave to drain, and enter in new bath, containing

¾lb. nitrate of iron.

Work one hour, rinse. Dye in fresh bath, with necessary amount of malachite green and fustic extract.

Red on Jute.

Boil in water for 1½ hours; wash and work in new bath with

2 per cent. azo red,
2 per cent. alum,

for one hour at 170° F., whiz and dry.

Black on Manilla Hemp.

I. Ordinary Black—50lbs.

2½lbs. logwood extract.
1lb. lime.
2lbs. copperas.

Work the goods three times in the boiling bath of the extract, leave to drain, then immerse without rinsing in the lime, and immediately afterwards in the copperas; give three turns and the dyeing is complete.

II. Finer Black—50lbs.

Employ

3½lbs. logwood extract,

and proceed as for ordinary black. After draining after the iron mordant the goods are re-entered in the logwood bath, then after wringing hang up in the stove or open air. One man will be able to dye 250kilos ordinary, and 200kilos fine black in one day.

WOOL.

CHAPTER VII.

SCOURING.

Wool is scoured either in the unspun or loose state, or in the form of yarn or cloth, and consequently the processes vary accordingly.

It will be remembered that wool contains a pretty large amount of yolk or suint; this will have to be removed, and all impurities be eliminated, if the wool is to be dyed in the unspun state, as is very often the case.

For the scouring process, weak alkalies are generally employed, as stale urine, soda or potash, and soap. Soda is the agent mostly employed; in some cases also silicate of soda. As a rule, the scouring is preceded by the steeping of the loose wool in water, in order to remove the yolk, which, as is well known, is soluble in water. This is effected in a systematic manner by treating the wool in a series of tanks. The liquor, after having reacted in one tank on one lot, is allowed to react on the other, and so on, until it is obtained in a concentrated form, when it can be evaporated to dryness for the recovery of potash, or better, treated with acid, in order to separate the fatty matters.

The scouring process, which is likewise applied to yarn or cloth, is also performed by means of alkalies (principally carbonate of soda or soft potash soap), at a temperature which is never allowed to go very high, especially for good qualities of wool, in which case soda crystals, or, at all events, a carbonate of soda, is employed, perfectly free from caustic soda, at a temperature of 400° C. In some instances, even ammonia, or carbonate of ammonia, is employed;

these are excellent for the purpose, but are too high in price. If soap be used, a 3 to 5 per cent. solution will be found to give good results, while a soda solution is generally employed at 1 to 2° Tw., containing 1 to 2grs. per cent., at a temperature not exceeding 45 to 50° C.

In the last few years, the employment of volatile solvents, such as benzene, petroleum spirits, and bisulphide of carbon, have been recommended for the extraction of grease from raw wool, and the processes have been found in some cases very useful, the only drawback attached to these methods being the danger of fire.

When scouring yarn it must be remembered that it contains about 10 to 15 per cent. of oil, which was added previous to spinning.

The operation is performed also by means of alkaline solutions, at low temperature, by working in ordinary dye-becks heated by steam, the hanks being worked as when dyeing, and, if necessary, scoured twice in a new bath. In many instances scouring machines are employed, the hanks being linked together in the form of a chain. The same remarks apply to woollen cloth, which is also scoured on machines in a continuous way.

WASHING WOOL.*

A potash soap always should be used, if it is desired to get the wool in the best possible condition for carding or spinning, with a minimum loss of weight in washing. The use of potash instead of soda soap for this purpose cannot be too strongly insisted upon. It is a very "penny wise and pound foolish" proceeding to use soda soap, or soda in any form, for washing wool. The difference between the cost of potash and potash soap, as compared with soda and soda soap, is not one-twentieth part of the loss incurred by the inferior handle and condition of the wool, and the greater loss

* The above particulars on the washing of wool have been abstracted from a pamphlet by Mr. W. J. Menzies, of the Greenbank Alkali Works, by kind permission of the author, and represent a very valuable experience on the subject.

in weight when soda is used; this is no theory, but an established fact, which has been verified by many large wool washers and worsted spinners both in England, Germany, and the United States. As a matter of fact also, if the potash soap is made by the consumer himself, it will not cost so much as is paid to the soap boiler for a good hard soda soap.

The quantity of potash soap necessary will depend very much on the quality and condition of the wool. If of common quality, dirty, and very greasy, it will require more potash soap than the finer qualities, and should then be assisted by the addition of a little refined carbonate of potash or pure pearl ash—an article specially made for the purpose.

The potash soap should be made up into a strong sud by dissolving it in about five times its weight of water, and this added to the washing bowls as required. The refined carbonate of potash should also be dissolved in twice its own weight of water, and a small quantity added, from time to time, as the sud gets exhausted with washing; or the two may be previously boiled together, and thus added to the machine. On no account should soda ash, carbonate of soda, or crystal carbonate be used with potash soap, as this simply destroys the whole advantage gained by its use.

In the case of very common wools, or Scotch laid wools, a good quantity of refined carbonate of potash should be used to assist the soap.

Skin wools must be specially treated, as they are very difficult to scour. They have been removed from the dead skin either with lime, an acid, or sulphides. An ordinary soap has no effect on these wools if treated in the usual manner. The best method is to thoroughly steep this wool in lukewarm water, to which a small quantity of refined carbonate of potash has been added. By following this course the acid is neutralised, or the lime which kills the soap removed, and the wool can then be washed as other wool.

Another important point is the temperature of the water. It should not be too hot. Hot water certainly washes more

quickly, but it causes a greater loss in weight. Any temperature that the hand cannot bear is too great, though dirty, very greasy wools require a greater heat than the cleaner qualities; no exact temperature therefore can be given. Hot water also takes out the natural curl of the wool, and thus destroys its spinning power. Nothing can be more important than close attention to all these points in washing wool. It is a far more important operation than is generally suspected. Many a bad spin is due to nothing else than bad washing in too hot water with soda soap; or, what is infinitely worse still, by washing with soda ash alone, carbonate of soda, or crystal carbonate, which is often recommended by the makers for washing wool. These articles are quite unsuitable for the purpose, and also destructive to the fibre of the wool.

A good washing machine is a great assistance in washing wool. It should have several bowls and good rollers. Petrie, and also McNaught, of Rochdale, and Jefferson Brothers, of Bradford, are all good makers. In America, Sargent's Sons, of Graniteville, Mass., turn out a good machine. With apparatus of this kind, soap can be economised, and the wool more completely cleansed than is possible by the old hand method. In the first bowl the soap should be strengthened by the addition of the refined carbonate of potash; in the last bowl many wool washers prefer to use potash soap alone, so as to lubricate the fibres, and give the wool a soft and silky touch, which can only be obtained with a pure potash soap.

Although, as it has been already said, it is difficult to give precise directions as to the exact proportions for use of soap and refined carbonate of potash, and the method of proceeding in wool washing, each manufacturer varying somewhat in these details according to the class of wool used, yet it may be useful, as an illustration, to give the actual practice of one of the largest wool washing establishments of Great Britain. The wool generally used is of average greasy quality. The machines here have three bowls. The soap used is a cotton-seed oil potash one, made

on the spot. It is dissolved in the proportion of two pounds of soap to the gallon of water, with one quarter of a pound of Greenbank refined carbonate of potash added, the whole being boiled up together. The machine is supplied with this liquid potash soap as follows:

Third or last bowl—Six gallons of liquid potash soap added. Temperature, 120 F.

Second bowl—Receives soap suds from third bowl, with further 3 to 6 galls. of the liquid potash soap added as required.

First bowl—Receives soap suds from second bowl, with 3 galls. of the liquid potash soap added. Temperature, 130 to 140 F.

If, however, the wool is very dirty, three gallons of a liquid soap made up as follows are added to the first bowl

24lbs. potash soap,
72lbs. refined carbonate potash,
80 galls. water.

This mixture is most effective with very dirty wools.

The average consumption of soap in this establishment is 19lbs. of potash soap, and 2½lbs. of Greenbank refined carbonate of potash to the pack of 240lbs. of wool. The wool is most thoroughly cleaned, and in handle and appearance nothing could be better.

In another part of the work will also be found directions for the making of potash soaps.

BLEACHING.

The bleaching is accomplished by means of sulphurous acid, principally by exposing the wet goods to vapours of burning sulphur in closed chambers; in late years also by the employment of bisulphites, principally bisulphite of soda and hydrochloric acid, either in the same bath or in two separate baths. If it were not so dear, the peroxyde of hydrogen ($H_2 O_2$) or oxygenated water would be the best.

A process describing the method now employed on the Continent, for bleaching woollen goods by means of the hydrogen peroxyde, will be found in the author's work on

"The Printing of Cotton Fabrics," being a communication by M. Horace Koechlin, of Loerroch, the method being employed for woollen tissues that are bleached before printing, and a very good white is obtained.

The following series of operations is often employed in the bleaching of woollen goods:

For 40 pieces of 20—30 yards each.

1st.—Singeing.*

2nd.—Pass three times through bath, containing 11—12lbs. soda crystals, 5—6lbs. soda to 60—70lbs. water, and which is heated to about 40° C. After each passage through the bath, add 4—8ozs. soap.

3rd.—Rinse in two clean waters of same temperature.

4th.—Run again three times in a similar bath to the first, but without soap, and add after the first passage 4ozs. more soda.

5th.—Sulphur for 12 hours in the chamber, by burning 11—12lbs. sulphur.

6th.—Run again three times through bath containing 13—14lbs. soda to 60—70lbs. water, at a temperature of about 50° C; adding ¼lb. more soda after every passage.

7th.—Second sulphuring as before.

8th.—Repeat No. 6.

9th.—Wash in two waters at 30° C.

10th.—Third sulphuring for 12 hours.

11th.—Wash twice in lukewarm and once in cold water.

12th.—Finally blue with indigo carmine.

These operations are generally sufficient for ordinary woollens; if they contain much colouring matter, or if they are destined for fine colours, the process is as follows:

1st.—Singeing and washing in water.

2nd.—Pass through alkaline soap bath containing 11—11½lbs. soda crystals, and 4—5lbs. soap for 60—70 galls. water at a temperature of 60—70° C.

3rd.—Rinse in warm water.

4th.—Give two passages in a bath like the No. 2, but without soap, at the same temperature.

5th.—Wash once in warm water.

* This operation is performed for fine woollen tissues, and relies on the same principle as the singeing of cotton goods. The singeing machine is shown on plate 30.

6th.—Sulphur for 10 hours with 11—12lbs. sulphur for 25 pieces.

7th.—Wash once.

8th.—Pass twice through a bath of 7—7½lbs. soda to the same quantity of water as No. 2, but at 60—70° C.

9th.—Run twice through a bath of 6lbs. soda for the same quantity of water, and at the same temperature.

10th.—Wash once in warm water.

11th.—Sulphur again with 8lbs. sulphur for 25 pieces of goods.

12th.—Wash once, and

13th.—Blue with indigo carmine or extract.

To preserve the whiteness of goods pass after the sulphur-bleach in a bath of 4½ galls. water containing 1—1½lb. hard soap, and ½—¾lb. ammonia, which preserves the goods from becoming yellow in store, and keeps them soft to the feel.

THE BLUEING OF WOOLLEN GOODS AFTER BLEACHING.

The blueing or tinting is still an important operation in the bleaching of wool, and is yet performed to a certain extent with indigo, carmine, or the extract of indigo, which being of a greenish hue used to be employed along with a certain amount of cochineal carmine in order to give a redder shade.

Since the introduction of aniline colours special preparations of reddish blues have been used, which are generally employed in solution, and added to the final scouring bath; but every firm has its own method of employment, and the dyestuff solution is selected according as a reddish or greenish shade is wanted.

WOOL DYEING.

Wool is dyed very largely in the unspun state, because in this form it allows the production of very even colours on the finished cloth, since, during the process of spinning, the fibre, by undergoing the mixing process, forms a thread in which the colours are evenly distributed, and, consequently, the finished cloth also joins considerably in this respect. Much attention has been given of late to the dyeing of wool

before spinning, and the numerous processes patented and taken out, are a proof of the importance of this branch of dyeing. Among the different methods introduced of late into practice, the following are worth mentioning. They all refer, of course, to the introduction of mechanical arrangements to substitute the work of the hand, since they do not bring with them any changes in the chemical dyeing operations. All these methods may be classed therefore under the name of mechanical processes for dyeing loose wool, and among them may be noted the Cerrutti-Sella, Fig. 9, the Smithson, the Obermeyer, &c., of which the apparatus will be illustrated here, with a description of their principle of working.

THE SMITHSON'S DYEING PROCESS.*

Most people who have worked with steam as a water-heating agent will have noticed that when the water gets up to, or near, the boil, all around the steam pipe the water rises up considerably higher than in any other part of the vessel. Many have, no doubt, noticed it scores of times, and taken no further note. Not so with Mr. Smithson, however. He seems to have asked himself the question, "If there is this current with one pipe, what will there be with a number?" and by persevering with the idea succeeded in bringing the thing into practical shape shown before us. To enable us to realise better the action of the apparatus, it is necessary to imagine the current that we notice boiling and rising up outside the steam pipe in a cistern of boiling hot water to be taking place inside, and the steam pipe itself being surrounded by steam in place of water—in fact, just reverse the picture, and put water where we usually have steam, and steam where we usually have water, the only difference being that a number of pipes are used instead of one.

* From a lecture by Mr. J. B. Wilkinson, before the Society of Dyers and Colourists in Bradford in 1887.

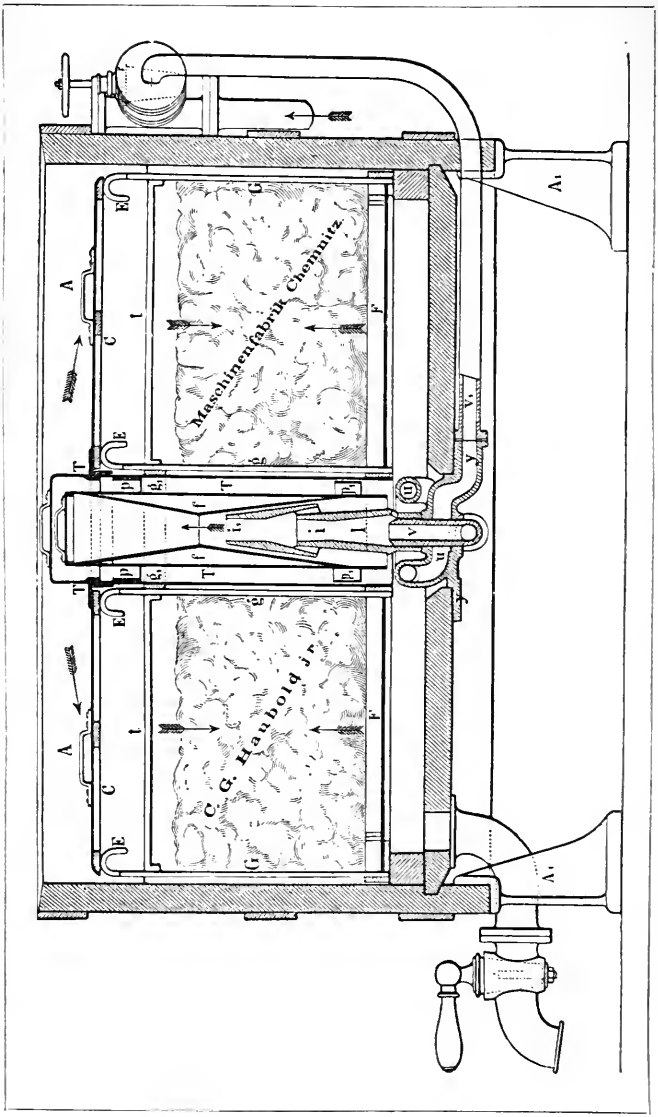


Fig. 9.—THE CERRUTTI-SELLA DYEING APPARATUS.

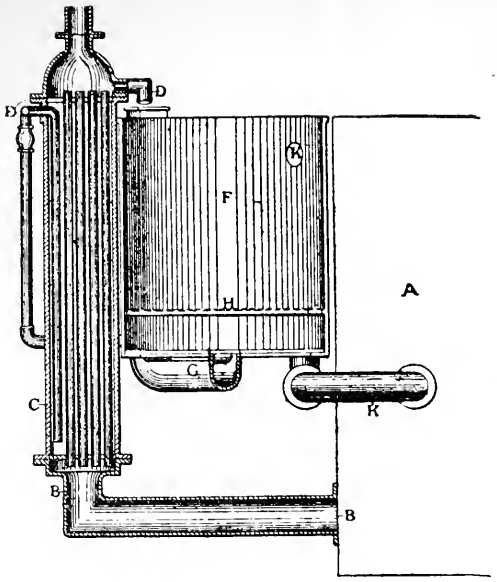


Fig. 10.

In the apparatus the dye cistern is at A, and from the bottom a current of water comes into B, and the pipes contained in the cylindrical vessel C are surrounded by steam, the steam heating the water in the same way we know it does in the ordinary cistern. The water coming from the dye-bath being near boiling, the heat carries it upwards till it is delivered at D. E is a flange which prevents the steam getting higher, the pipes being open at the top. The current rises up above these, and passes forward into the vessel F, which we may term the "extractor." This vessel contains the chipped wood—logwood, fustic, or whatever it may be. The water passes down pipe G outside the vessel, and is delivered from underneath, entering in between the bottom of the vessel and a perforated grate H, which sustains the dye materials. The water, which is perhaps a trifle above the ordinary hot water point, passes up through the wood and down another pipe K, then discharging itself into the dye vessel.

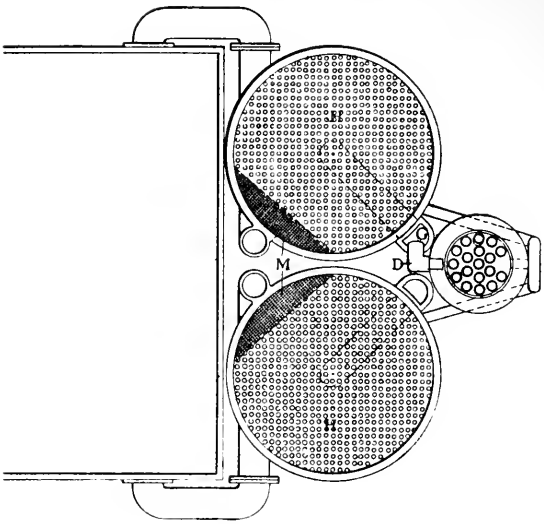


Fig. 11.

Fig. 11 is a cross section, in which we see the top of the pipes. Here, if we could see it in actual work, the water would be springing up through these pipes. At D it would pass forwards, and down pipe G to the bottom of the extractor. The perforated bottom is shown at H, and near the top is another perforated plane M, the object of which is to prevent any bits of wood or other foreign matter from passing with the water into the dye cistern. Fig. 12 is a side view of the machine just as it stands. At S is a pipe going from the dye vat. C is the steam box and the pipe supplying steam to heat the water, and at P is the exhaust which takes the condensed steam away from the steam box, this condensed steam being either blown into this vessel, containing extracted matter, or turned out of the vessel altogether at will. At Q there is an open space, which allows any excess of steam to pass out. Fig. 13, again, is a front view of the apparatus. We have here two extractors shown; the reason why there are two being that whilst one is working the other may be emptied and refilled, and,

therefore, there will be no loss of time. You will notice that there is a valve or tap R for the purpose of letting out any little particles of matter, bits of wood, etc., which

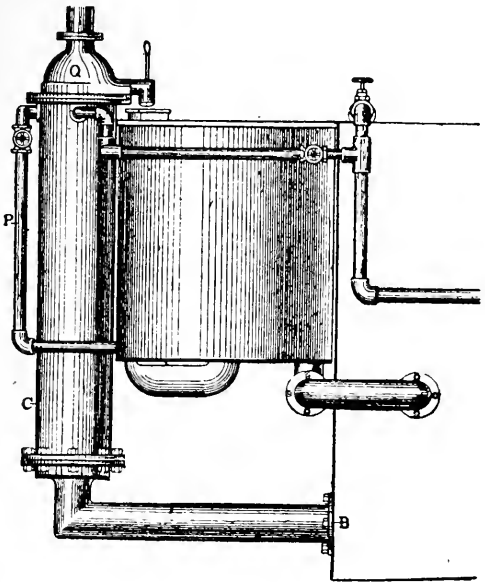


Fig. 12.

happen to fall through the perforated bottom. We may note here that it is not necessary to have the extractor close to the cistern. It may be anywhere about the place, the only difficulty being the loss of heat which would occur through the pipes being long. The idea seems to have been that if the logwood place is handy, the extractor should be placed in it, and so have the whole affair quite separate and altogether distinct from the dyehouse. The only objection so far as can be seen to that is the amount of cooling which would take place if the passage was of any great length.

Now, having described the apparatus, let us turn our attention to its capabilities for the use of the dyer—First,

for loose wool, rags, etc.; second, for slubbing, yarn, etc.; third, for piece goods. Taking these first in order then—viz., loose wool dyeing—for our purpose let us take black dyeing, as perhaps being the best for illustrating our subject. The usual process is first to prepare, then wash, and then dye. This requires the wool to be lifted twice

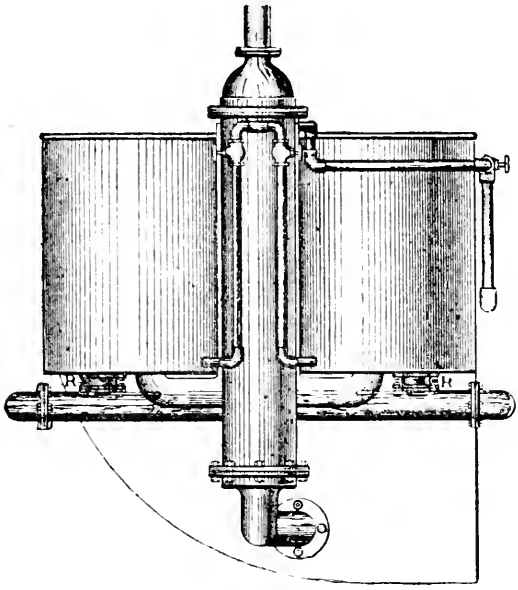


Fig. 13.

once out of the chrome bath and once out of the dyebath, and we may lift out of the chrome bath either (*a*) by hand direct, (*b*) by fishing out with a long pole, or (*c*) by lifting altogether in a cage let down in the bath.

So far as labour is concerned there is not much difference between the first and second, as a man will fish out pretty near as soon as another could let off, and wash, or cool down; but there is a distinct saving of heat and liquor, because the liquor is not run out of the pan, only what is carried along with the wool.

Then we come to the third or cage method. Here, although we get the material out of the liquor quicker than by either the first or second methods, there are other drawbacks and disadvantages that have to be set against it; for instance, there is not that free circulation of the liquor that there is without the cage; and again, if the cage be of wire, as usually is the case, the men must be more careful with their handling up, and men who are accustomed to the use of long poles in a dyehouse are not, as a rule, the most careful class; besides, it requires a dyehouse to be pretty lofty, or there is not room to wind up sufficiently

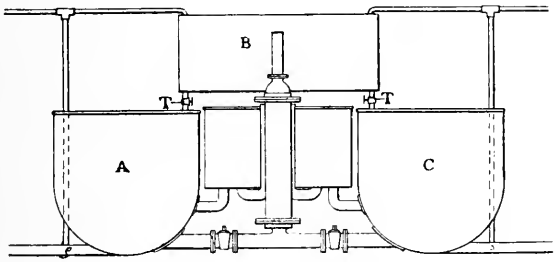


Fig. 14.

high; and again, besides all this, there is the large amount of room taken up in the vessel by the cage itself, which prevents the same quantity of material being dyed at one time than otherwise might be when the cage is not used; and there are also the extra wear-and-tear expenses that have to be taken to account. So far, then, we have discussed the methods that are in ordinary use daily—viz. (*a*) lifting out in ordinary way; (*b*) fishing out by means of the pole; (*c*) lifting it out in the cage altogether.

We will now examine another method which Mr. Smithson proposes, and which he claims will have nearly all the advantages, and obviate some of the difficulties, of the other systems. Fig. 14 is a sketch of the proposed arrangement, consisting of three vessels, which we will call A, B, and C, and in imagination, we will go through the routine of dyeing in these vessels.

First, then, we fill the vessel A, heat up, and prepare in the ordinary way. When finished, we pass the liquor in a reserve B, which may either be above, as shown in the drawing, or may be in a tank below the vessel A. This may be arranged according to circumstances. Whichever way we do we have the liquor once to lift, which is done by means of an ordinary steam pump. We now wash our prepared wool, which is then ready for dyeing.

Meantime, whilst we have been preparing the wool in A, we have also our vessel C got up with logwood for dyeing the wool prepared in A, and accordingly we will lift out of A, throw into C, and dye in the usual way. Whilst dyeing, however, we bring back our preparing liquor into A from B, and commence to prepare another lot, which we do in the usual way. After preparing we wash, and by this time our liquor in C is consequently exhausted. We now bring our new apparatus into work, and bring over the exhausted liquor from C into A, put the required amount of chipped logwood into the extractor, and set it going. When our vessel C is emptied of its liquor we empty out the wool, and commence to prepare same as we have done in A, by bringing the liquor from the reserve B that was last used in A into C, give it its time, etc., then bring back again the exhausted liquor from A, and so on indefinitely until it is thought desirable to change the liquor altogether.

Now, having described the method of procedure, let us see what we gain by it, as unless some advantage is to be gained, the game will not be worth the candle; therefore we will endeavour to carefully examine the advantages that are claimed for it.

First, then, upon process which we will call No. 1, there is a distinct gain of both fuel, labour, and time, because the hot liquor is reserved, thus requiring less fuel to heat next time, and less labour, because we have it to lift out only once instead of twice, and of time because less is required to prepare the bath for the next round, and thus to enable more work to be got through in a given time. There is an advantage over the No. 2 plan through a saving of time, as it

will be run off quicker than it could be fished out, and also less liquor will be wasted than by fishing out, and labour is saved because it is only once to lift, as is explained before; therefore we have again time, fuel, and labour saved. Coming now to the third or cage method, we do away with all cross-bars over the pans, leaving all clear for handling up the material, and we save the labour and time of once lifting; also there is saving of logwood bags.

Now let us turn our attention to slubbing dyeing. Here the material is in a better condition for lifting and handling about. But whilst the slubbing dyer has this advantage over the loose-wool dyer, he has a disadvantage that more than counterbalances it, which is that he must handle and lift it about as little as possible, or he finds himself in difficulties that the loose-wool dyer does not dream of; and to see the difference between an old-fashioned loose-wool dyer, who likes to see pans boiling and lifting like a fountain, and the careful handling of a slubbing dyer, is marvellous, when you think they are both dyeing the same kind of fibre. The one believes in giving it a thorough rousing up—the other is careful to keep every hair as straight as possible; one believes in boiling his colour into it—the other believes in its being out of the boil, if he can obtain his colour without. They are at the antipodes of each other, and each believes the other is in a perfect paradise from his own: the one because he says the slubbing dyer can lift out his materials so much easier, and add anything to his bath that he wishes, and the slubbing dyer because he says the other has nothing to do but throw his stuff in and boil till he gets his shade.

For slubbing dyeing an arrangement is suggested in which the slubbing should be laid on a perforated bottom, the apparatus set in motion, and by circulating the liquor up and through the wool it will be lightly suspended, and in consequence will allow the colouring matter to circulate freely—more so than if a current of liquor was circulating downward, which would, perhaps, have a tendency to lay sadder at the bottom of the vessel.

The present apparatus seems to combine the utility of the circulation principle, and we may preserve the simplicity of the ordinary stick when it may be desirable, as commonly used, by allowing the sticks to dip below the surface; and putting a perforated plate over the liquor we get a complete circulation of the liquor in the bath. Seeing that it is possible to have the delivery anywhere where required, it seems to my mind well worth the attention of slubbing dyers, as with their existing plant very little attention would be required. It would, in the matter of heat, be a distinct gain, since if we blow steam direct into the bath we run the risk of blowing the materials, whilst to lift and heat up involves loss of time; whereas by the use of the apparatus we may keep up the heat, not only as well, but actually better than by the ordinary methods, because, as has been previously stated, the liquor is delivered in a hotter condition than it could be by blowing in steam direct. Again, whilst by the admission of steam direct into the bath it is continuously becoming weaker through the condensed steam, by this the tendency would be in an opposite direction, which is of distinct advantage in all colours that are very soluble.

As applicable for black dyeing, it will undoubtedly have a tendency to produce evenness of shade, because by commencing in an exhausted liquor, and gradually working up, the whole batch has a better chance than when one portion is dipped down into a full-strength liquor, the same as at present.

What may be fairly claimed for its interests to the slubbing dyer, then, are as follows:—First, a steady circulation of liquor; second, a higher temperature in the bath without the use of direct steam; third, a saving of labour and time where chipped woods are used; fourth, an intimate admixture of the colouring matter in the bath, without the necessity of lifting his slubbing out; fifth, freedom from bits of wood, etc., that get in from torn bags, etc., and also the expense of the bags is saved.

For the yarn dyer much the same may be said as for the slubbing dyer, as being worked in a similar manner

For piece dyeing it must be a distinct advantage. We may, however, divide them into two classes—those who use chipped woods (*i.e.*, the heavy cloth dyers), and who throw the wood into the vessel; and secondly, for stuff dyers, who mostly use rasped wood. Let us take the heavy cloth dyer first. His method is usually to throw in his chipped woods, boil down and enter his goods, and so on, until his wood has accumulated at the bottom of his vessel in such quantity that he must either let off or fish out (usually with a kind of net), or send it down the drain. This answers well enough for some classes of goods that are of a close and fine texture, such as fine worsteds, or what are generally known as fine goods. In this class of goods the small pieces of wood leave the goods without adhering, and may be easily shaken off. Not so, however, in some other classes of goods, such as curls, etc., in which the surface of the goods is very rough; here the small particles of wood become entangled in the cloth, and are difficult to detach, except by special hand labour, which must of necessity add to the cost. To keep the woods out, then, from such goods, is of special importance to any dyer who has this class of work to deal with, and he has resort either to extracts of the woods or strong liquors, either of his own make or bought for the purpose. Neither of them are as economical as if he could use his woods direct. To such the apparatus is like the renowned pens; it comes as a boon and a blessing to them, for it not only enables them to use the woods direct, but it keeps them free from the troublesome bits before mentioned. Now the other class of dyers, such as stuff dyers. These people use rasped woods, and, like the others, they put them direct into the baths. But woods cost more to the dyers rasped than chipped; in fact, of all the various methods of using woods, and more especially say logwood, none are so cheap as using it in the chip. Well-matured chipped logwood is in the very best condition that a dyer can have it, and that being so, it is not the stuff dyer who wishes to use logwood in a dearer form if he can have it in a cheaper. Here, then, the apparatus steps

in to his aid, and enables him to use the wood in its cheapest and best condition, with every advantage that he has from the rasped; and if, considering the extra cost per ton of rasped wood, we note how distinct its advantages are, it must, in a very short time, pay its own cost.

For the piece dyers, then, the following advantages may be claimed:—First, a readier method of extracting the colouring matter of the woods for direct use; second, complete immunity from small bits of the woody fibre, so difficult to rid when fixed once; third, the use of the chips in place of rasps, which is a direct saving in cost; fourth, being better able to keep the drain clear from wood, etc., a distinct saving of time, labour, and expense of lifting.

THE OBERMEYER MECHANICAL DYEING PROCESS.*

That modern industry ceaselessly aims to make itself independent of hand labour is a fact well known, and many useful apparatus and contrivances have been already devised for effecting this object in the different branches of the tinctorial trades. The dyeing of loose wool and cotton also have had their share of attention at the hands of inventors, without, however, bringing forward any very striking changes over the old methods, until within the last few years. The process under consideration may be considered as a thoroughly modern method. It relies, of course, on the well-known and necessary principle of effecting a circulation of the dyeing or mordanting liquids; but, unlike the older systems, the material is left standing, while the liquids are kept in motion. It is to the mechanical arrangements, therefore, that our attention must be first given, and then to the amount and quality of the work performed. As will be seen from the illustration, the dyeing apparatus consists of a cistern in which the dyeing or mordanting operations are performed. The material is placed in the cylinder, which is a perforated vessel of copper, or even galvanised iron, according to the

* From the *Textile Manufacturer*, January, 1887.

nature of the bath, and this cylinder is fixed at the bottom of the cistern, and put in communication with a centrifugal pump, which forces the dyeing or mordanting liquors through a pipe into the cylinder, and after reacting on the material through the perforations all over the surface of the cylinder, back again into the dyeing cistern. This latter is filled only with sufficient liquor to effect the dyeing or the mordanting of the material, and consequently it is possible to work with stronger liquors, which means also a saving in the fuel, since only small quantities of liquors have to be heated, and not as in the old process of having to heat comparatively a large amount of liquor for a small quantity of the material. The liquors in the cistern only average in all about 15 inches. The construction of the cylinder or receptacle for holding the material to be treated, differs according to the nature of the material itself, and consists either of a plain cylinder, with a perforated column in the middle with which it communicates with the pump, or the apparatus is of more complicated construction, having one central cylinder, and several others protruding from it, in which the material is placed, and is especially suitable for the dyeing of tops. In both cases the main cylinder is supplied with a lid to press down the material and keep it in its place, and at the same time to allow, by means of a hook at the top of the lid, the whole of the cylinder to be lifted up and down by a crane, and thus a great saving of labour and handling is effected. To this must also be added the advantage of its being possible to do all the operations of mordanting, dyeing, or washing, without removing the material from the cylinder. The drying may similarly be done without removal of the material, it being only necessary to put hot air through after the drying and washing off are completed, since from the first placing of wool in the apparatus, to its being completed in a dyed and thick state, there is no handling required. As to the amount turned out, three men will do 12,000lbs. to 15,000lbs. of wool a-week, of course according to the quality of the wool. The dyeing of blacks especially

seems to be effected with special ease and thoroughness by this system, either for wool in the sliver or loose wool; the method of dyeing being the well-known process of mordanting with bichromate. This operation lasts one hour; the dyeing itself takes $1\frac{1}{2}$ hours for the washing, or $2\frac{1}{2}$ hours in all.

A large cylinder will hold 200lbs. to 300lbs., and a larger one has just been constructed to hold 500lbs. of wool. The process of dyeing can be closely watched, and samples taken out by a small manhole arranged at the top of the lid. All colours are dyed by this system without any difficulty; either dyewoods on mordanted material, or aniline and coal tar colours generally without any mordants; and in all cases it seems possible to obtain very even dyeings, the wool keeping all the time its lustre, and not being exposed to any rough handling, is not liable to felting.

A further advantage claimed for this process is that it renders the re-combing of the dyed wool not absolutely necessary, as in many cases it can be dispensed with. The author has seen the above process and apparatus at work at Mr. R. Markendale's, Adelphi, Salford, to whom he is also indebted for information regarding its working.

The Yarn and Cloth Dyeing have not undergone much change in the last few years, since they attained a high state of development years ago, and the machinery employed had then already reached a very high degree of perfection.

Although machines for dyeing woollen yarns have been introduced, the work of the hand is still the one mostly employed, and, for the majority of cases, could scarcely be substituted by the work of the machine. Consequently, in the following remarks, attention will principally be given to the classification of the now very numerous methods of dyeing the wool fibre, irrespective of being either loose or in the form of yarn or cloth.

The dyeing of the wool fibre may be divided in two great classes: dyeing on mordants, and dyeing without

mordants. But we will follow the other classification of the cotton dyeing, and divide the methods according as they employ: *The Coal Tar Colours, and the Natural Organic Dyestuffs (Dyewoods, Indigo, etc).* So far as the mineral colours are concerned, we may say that they have practically ceased to have any interest for wool dyeing.

The Coal Tar Colours must also be here subdivided into basic and acid dyestuffs, as the difference between the two classes is of even greater importance for wool than for cotton dyeing. To these two classes may be added also the alkaline dyestuffs: those which are fixed in an alkaline bath; and, finally, the alizarine colours, which, although they could be classified as acid colours, differ from these in that they require a mordant for their fixation, and consequently must be regarded as a class thoroughly distinct.

The Basic Aniline Colours.

These have lost importance considerably since the development of the now very numerous class of acid colours for wool. Of the basic dyestuffs, which are all dyed in a neutral bath (seldom by the addition of acetic acid, which is indeed only added to neutralise any lime in the water), sometimes by the addition of a little glauber salt, we may mention *Magenta* or *Roseine* for light rose colours, up to blueish reds.

Cerise, Cardinal, Maroon, &c., being impure magenta colours, giving special shades of red, and not so bright as magenta.

Bismarck Brown, chrysoidine and phosphine the violets.

Methyl and Malachite Greens are seldom used now for wool dyeing, being substituted by the more convenient acid greens.

Aniline Blues, soluble in spirit, are of little importance now for wool dyeing, but they are still employed when colours are required which have to stand milling, also for tinting or blueing to a moderate extent. Under the

name of stoving blue a product is sold giving shades standing milling and stoving.

Other blues, such as Victoria blue, methylene, etc., are seldom employed.

ACID DYESTUFFS.

Of the coal tar colours for wool dyeing, this class is the most important and valuable addition, since it gives a very convenient series of dyestuffs, which can be employed on wool in an acid bath, which is a great advantage for this fibre. There is no end to the shades that can now be produced by means of these acid colours by themselves, and in connection with each other. These products are all sulpho compounds of the basic dyestuffs.

Reds.—Acid magenta is a valuable product, being faster to light than ordinary magenta.

Azo Scarlets.—A great variety of products are now on the market, under different names, such as ponceaux, scarlets, croceine and others, giving very fine colours, beginning from purplish reds, full reds, scarlets of a red or yellow shade, and in fact the range of colours does not stop there, but goes down to *Oranges* of different gradation down to *Yellows*, etc.

It would not be of very great interest to describe all these colours individually, the more so that they come on the market under so many different names that a description of the method for each single colour would be hopeless.

It will be well, therefore, to consider all these dyestuffs as a class of acid colours, and the method of their employment is the same for all. They require an addition of sulphuric acid to the bath, to which glauber salt is also added in the proportion of 10 to 20 per cent. As far as the proportion of sulphuric acid is concerned, it depends upon the different dyestuffs; some dyers acidulate their bath until it is frankly acid. About 2 to 5 per cent. of sulphuric acid will be found sufficient in all cases. The amount of dyestuff required depends upon the shade required. For scarlets, for instance, 2 to 3 per cent. of

some brands will give a very full shade. Among the other acid colours may be mentioned—acid naphthol yellow, picric acid, etc.

Blues.—The soluble blues of greenish shade are preferably employed, as alkaline blues will be mentioned later on. The soluble blues of red shade, such as for serge, navy blues, etc., are common soluble blues, which are fixed on wool in the ordinary way in a bath strongly acidulated with sulphuric acid, and with the further addition of glauber salt, a lengthy boiling being required if dark shades are wanted.

The *Induline Blues* give navy blue shades, up to blue blacks, which stand light remarkably well, and they also are dyed in an acidulated bath, and require a long boiling for the fixation. Often also they are dyed on wool, mordanted with bichromate of potash, when more intense and even faster shades are the result. It is well in dyeing with these colours to start first in a neutral or slightly alkaline bath; enter warm, bring quickly to the boil, boil half hour. Then add in small portions at a time 5 to 10 per cent. sulphuric acid, and keep boiling until the desired shade is obtained. Blues dyed with induline are considered the best substitute for indigo dyed blues.

Acid Violets and Acid Greens do not call for any special remarks for their method of employment, except that they are found very useful as combination colours, the greens especially being employed to a certain extent as substitutes for indigo extract and carmine in compound shades.

THE ALKALINE COLOURS.

This class comprises, besides the alkaline blues, which are very important, some other products, such as alkaline violets and greens, which have, however, not been found so useful as the other. They are also called Nicholson blues.

The new class of azo colours, which dye cotton without mordant, might also be classed here, since they are also dyed

in an alkaline mordant, but they have already been described in the chapter relating to cotton.

*Alkaline or Nicholson Blues.**

To make a solution.—Dissolve about one pound of colour in ten gallons of water, and boil for 15 or 20 minutes.

The liquid Nicholson blues also found on the market will be found to effect a great saving of time and trouble.

For wool.—These colours, which are very largely used for wool dyeing, both for pieces, yarns, slubbing, and all classes and kinds of wool, are specially characteristic for brilliancy of shade, power of penetration of even the thickest fabrics, and the peculiar method of dyeing. Two baths are required: the dye bath, and the acid or developing bath.

To the dyebath, an amount of borax or soda approximately equal to the weight of colour used should be dissolved and added, together with the quantity of colour necessary to produce the required shade. The wool should be entered at about 100° Fahrenheit, the temperature quickly raised to the boil, and kept there about half-an-hour. Take out, and wash well; the cleanliness of the ultimate colour depends largely on the goods being well washed at this stage. The goods should now appear a greyish or only pale blue.

Develope the colour by passing the goods through water slightly acidulated with sulphuric acid, at about 120° Fahrenheit; wash again well in cold water, and dry. On no account must the acid be put in the same bath as the colour. The water in the dyebath should be as free from lime salts as possible. In some cases, where the water is particularly soft, less borax or soda than above-named is necessary.

To match a given shade, cut off from time to time a

* The following particulars I owe to Messrs. Brooke, Simpson, and Spiller, of the London Atlas Works, where, as is well known, these products were first discovered and manufactured by Nicholson.

small piece of the goods while still in the dyebath, wash, and then develop it in the acidulated bath.

In working these colours for the first time, more dye is required than for subsequent operations. For instance, if you start a bath with 3lbs. of colour, the material to be dyed will not take up much more than about 2lbs.; but in a second operation, the addition of 2lbs. of colour to the dyebath will give about the same result as the first 3lbs. As, therefore, the bath cannot be exhausted, it should be saved until again wanted, or the colour may be precipitated with sulphuric acid, collected on a filter, washed with cold water, and kept in that state till wanted; then dissolved afresh with the addition of a little extra borax or soda.

When wishing to make colour as fast as possible against milling and scouring, it is a good plan to bottom with a little vat indigo. Many dyers think that developing in a rather hot acid bath, also tends to make these colours stand milling better.

Though strong soda will discolour an alkali blue, it will not destroy the colour, acid bringing it back to its original brilliancy.

It may be reckoned that from 5 to 10 per cent. of borax or soda crystals to weight of wool, is the quantity generally employed in the first bath.

THE ALIZARINE COLOURS.

In another part of this work will be found a detailed account of the alizarine colours, with methods of employment in connection with two pattern sheets, kindly supplied by the Badische Anilin and Soda Fabrik; also patterns of loose wool, dyed with alizarine colours, supplied by the Hoechst Colour Works. There will also be given recipes for alizarine dyeing

DYEING WOOL WITH ALIZARINE.*

All on 100grs. cotton.

1. Prepare bath of

4grs. tin crystals,
2 ,, oxalic acid,
4 ,, calcium acetate,
5 ,, alizarine (medium shade).

Heat to 160° F., enter wool, raise to a boil, and continue till exhausted. Dyed in one bath.

2. Mordant wool at a boil for two hours with

10grs. alum,
4 ,, tartar,
2 ,, tin crystals.

Heat, etc., as in 1, using in dye-bath 10grs. alizarine (medium shade).

3. Mordant as in 2, using in dye-bath 10grs. alizarine (blue shade).

4. Prepare bath of

4grs. tin crystals,
2 ,, oxalic acid,
4 ,, calcium acetate,
15 ,, alizarine (medium shade).

Heat, etc., as in 1. Dyed in one bath.

5. Mordant as in 2, and use in dye-bath 1·25grs. alizarine carmine and 1·25 grs. tartar.

6. Mordant wool at a boil for one hour with

2grs. alum,
0.5 ,, tin crystals,
0·5 ,, tartar.

And in dye-bath use

0·65grs. calcium acetate,
10 ,, alizarine (blue shade).

7. Mordant wool at boil for one hour with

2grs. alum,
1gr. tin crystals,
1 ,, tartar.

* These recipes were obtained from the British Alizarine Co., at the time of the author's connection with the Manchester School of Dyeing.

Use in dye-bath

1·25grs. alizarine carmine,
2·5 ,, tartar,
0·25 ,, calcium acetate.

8. Prepare bath with

2grs. alizarine (medium shade),
1gr. uranium acetate.

Heat, etc., as in 1.

9. Prepare bath containing

3grs. alizarine (medium shade),
1gr. uranium acetate,

Heat as in 1. Dyed in one bath.

10. Prepare bath of

0·5grs. alizarine (medium shade),
1·0 gr. uranium acetate.

Heat as in 1. Dyed in one bath.

11. Mordant wool two hours at a boil in

3grs. bichromate of potash or soda,
2 ,, oxalic acid.

Wash and enter in dye-bath with

1gr. alizarine (medium shade),
4grs. extract fustic.

Heat as in 1.

12. Mordant the wool, by boiling two hours in

4grs. sulphate of iron,
2 ,, tartar,
2 ,, oxalic acid,

Wash. In dye-bath use

2·5grs. alizarine (medium shade),
10 ,, extract fustic.

13. Manipulate mordant as in 11, and use in dye-bath

5grs. alizarine (medium shade).

Heat, etc, as in 1.

14. Mordant wool for two hours in

5grs. alum,
3 ,, bichromate of potash or soda,
2 ,, oxalic acid.

Take out, wash, and enter in dye-bath of

10grs. alizarine (medium shade),
5 ,, extract fustic.

Heat as in 1.

15. Mordant as in 14. In dye-bath put

5grs. alizarine (medium shade).

16. Manipulate mordant as in 6, and use in dye-bath

10grs. alizarine (medium shade),
10 ,, extract fustic.

Heat, etc., as in 1.

In another part of this volume, in chapters relating to communications received from different sources, and explanations of dyed patterns, will be found a description of methods of employment of some very interesting novelties in the class of coal tar colours for wool dyeing.

DYEING WOOL WITH NATURAL ORGANIC DYESTUFFS.

CHAPTER VII.

INDIGO DYEING.

The indigo vat is still employed in woollen dyeing, although not so much as formerly, for the production of those goods where great fastness is required against light and air. The fermentation or German vat is the one still employed for the purpose, which is prepared as follows: * For a vat of the capacity of

14 to 15,000 litres (320 to 350 galls.),

take

1 bag of bran,

about

2 litres treacle (½ gall.),
20 kilos soda ash (45 lbs.),
10 kilos indigo, very finely ground in water (22½ lbs.);

by means of a steam pipe the temperature is raised to 60 to 70° C.

After eight to fourteen days the fermentation may show itself, but sometimes it takes longer; this is due to the presence or absence of the necessary ferments to set up the fermentation. In order to hasten the beginning of the fermentation it is advisable to add to the vat a small portion from the bottom of another vat already in fermentation, which will contain the necessary ferment, and will start the fermentation in the new vat very rapidly. This is ascertained by the coppery line acquired by the surface

* The above details are extracted from an article by M. A. Renard in *L'Industrie Textile*.

of the liquid in the vat, which is covered at the same time with a thin film, the frothing of which also shows itself on the surface, and which becomes blue in contact with air. It is also recognised by the presence of blueish veins when the liquid is agitated.

By leaving the vat to itself for a few days, with only the precaution of agitating twice every 24 hours, the reduction will easily take place, and the vat be ready for work. The wool is introduced into the vat in a kind of basket, which is immersed in the liquor, but without allowing it to touch the bottom. The wool is gently moved in the basket in order to allow the liquor to penetrate throughout, and after 15 to 20 minutes, the basket is lifted bodily out of the vat, and the liquor allowed to drain back. These immersions and liftings out are repeated until the wool has reached the proper shade. Five or six dips can thus be made in one day. Every evening, after the work is over, the vat is stirred up after adding

About 10 litres bran (2 to 2½ galls.),
½ litre treacle (about 1 pint),
2 kilos soda (4½lbs.),
5 ,, indigo (10 to 12lbs.),

and a certain amount of lime, which can only be determined by practical experience. The temperature is brought to 35 to 40° C. A good vat shows the following characteristics: it is of a nice yellow colour, and shows a blueish froth at the top of the liquor, and numerous pellicles of a bronzy or coppery hue. On raking the liquor it should show blueish veins, and the bottom be of a greenish hue. The vat must show a slight ammonia smell. In all cases the conduct of this vat, as, indeed, of indigo vats generally, requires a large amount of practical experience, and no amount of description will make an efficient indigo dyer, without the necessary long practice.

The Benoist fermentation vat: It was proposed not many years ago to do away with the uncertainty in the managements of the fermentation vat, by employing a mixture of glucose and potato starch, made soluble by a

previous boiling with carbonate of soda, and by employing a special ferment, capable of resisting and reproducing itself at a temperature of 70 to 72° C., so that the dyeing might be effected at a higher temperature, and in a clearer liquor, than in the ordinary vat. By employing products of definite composite, it is possible to calculate exactly the amount required. The author is not aware that this new vat has offered, in practice, any advantage over the older process.

The Bisulphite, or Schutzemberger and Lalande methods. *Vide* Holliday and Son's vat:

For Woollens.—To set a vat, say 6ft. square by 7ft. deep, fill with clean water, and heat up to 130° F., then take 78lbs. of bisulphite of soda, which kill with 6lbs. zinc preparation, and stir for ten minutes (a zinc or galvanized iron pail is best for this); the bisulphite of soda will then be thoroughly killed, and have taken up all the zinc preparation, add this to the vat, then add 6lbs. dry slaked lime, then indigo solution sufficient for shade required.

To replenish vat, take for every 100lbs. of woollen goods, 10lbs. bisulphite of soda, killed with 13oz. zinc preparation, and stirred ten minutes before adding to bath; then add 8oz. dry slaked lime (free from stones, etc.), and then indigo solution to shade wanted—always keep the liquor to feel slightly rough and hard.

The vat is heated with a coil of pipes so arranged that the condensed water does not enter the liquor. Wool and woollen pieces should be dyed at 120° F., and woollen yarns at 105° to 110° F.

Observe that the proportion of bisulphite of soda, zinc preparation, and lime, for the quantity of wool to be dyed must be the same, irrespective of shade wanted, whether a quart or 10 gallons of indigo solution is required.

DYEING WITH DYEWOOD.

The dyewood colours still occupy a very prominent position in the dyeing of the wool fibre, and their

employment has not been diminished by the introduction of coal tar colours. Whether this will still remain the case in the future is very difficult to tell. It will depend upon the discovery of some artificial series of new colouring matters, capable of being entirely substituted for the natural dyestuffs. In certain branches, of course, the dyewood colours have been affected to a certain extent; but on the whole they have held their own.

Madder is still employed in the wool-dyeing establishments, principally for compound shades, but cochineal has suffered very considerably since the introduction of the azo scarlets, which have been found a very cheap and effective substitute. With reference to cochineal it is of interest to note, that in spite of assertions by the manufacturers that the azo scarlets are as fast as, and in respect of washing, even faster than cochineal, the fact remains that military cloth, not only in this country, but also on the Continent, is still dyed by means of cochineal, the authorities still insisting upon a cochineal dye being delivered.

Logwood is still almost exclusively employed in the dyeing of blacks on wool, for which the mordanting method with bichromate of potash is principally followed, as in the following examples:

CHROME BLACK ON WOOL.—No. 1.

Wool 100lbs.

1st.—Boil 1½ hours with

2lbs. bichromate of potash,
2 ,, sulphate of copper,
1 ,, sulphuric acid.

Wash well.

2nd.—Dye in new bath with

50lbs. logwood, for a blue black.

For *jet black* use

45lbs. logwood,
8 ,, fustic.

CHROME BLACK.—No. 2.

For 100lbs.

1st.—Boil 1 hour in bath with

5lbs. glauber salt,
5 ,, bichromate of potash.

Lift out and wash.

2nd.—Dye in new boiling bath with

15lbs. logwood extract, 51° F.
1½ ,, fustic ,, 51° F.

Give 8 turns, lift, wash, and dry.

Iron blacks are not so often used for wool.

Logwood enters in many compound colours, such as olives, browns, etc.; but the logwood blues are not much employed, there being such a variety of coal tar blues, which are very effective and advantageous substitutes for the purpose.

All dyewoods may be dyed on mordanted wool, the mordants mostly employed being:

Alumina Mordant.

Alum 5 to 10 per cent.,
Tartar 2½ to 5 per cent.,

according to depth of shade required.

Iron Mordant.

Copperas 5 to 10 per cent.,
Tartar 2 to 5 per cent.

Chromium Mordant.

3 per cent. bichromate of potash,
·25 (or ¼) per cent. sulphuric acid.

Tin Mordant.

Stannous chloride (tin crystals) 3 to 4 per cent.
Oxalic acid..... .... 3 per cent.

Tin and Alumina Mordant.

Alum or sulphate of alumina	10 per cent.
Tin crystals.....	2 ,,
Argol	5 ,,

On these mordants can be dyed the dyewood colours, such as fustic, bark, logwood, barwood, sanders, etc.

Persian berry extract gives good yellow on alumina and tin mordants, which are, however, too expensive; but bark or flavine give very good and cheap colours on the same mordant: alumina and tin, or tin alone. A good mordant for cochineal is 2 per cent. stannous chloride, or 3 parts stannic chloride, $3\frac{1}{4}$ parts oxalic acid. In mordanting with all about 1 to $1\frac{1}{2}$ hours' boiling is generally employed.

The following examples will be found interesting:—

Mordant with 2 per cent. bichromate potash; boil one hour. *Dye* with fustic barwood, logwood, and sanderswood.

Mordant with 1 per cent. alum and 1 per cent. chrome; boil one hour. *Dye* with fustic, barwood, logwood, and sanderswood.

Sadden half of each shade with copperas.

Mordant with 3 per cent. alum and $1\frac{1}{2}$ per cent. tartar; boil one hour. *Dye* with fustic, barwood, logwood, sanderswood, madder, archil, and cudbear.

CHROME FOR BLACK.

Blue reflection: 3 per cent. chrome, 25 per cent. sulphuric acid; boil $1\frac{1}{2}$ hours. Dye with 50 per cent. logwood.

For *violet reflection*, add 5 per cent. muriate tin to mordant.

For *green reflection*, add 10 per cent. fustic to dye-bath.

COCHINEAL SCARLET.

On 100lbs. wool, in one bath.

7 to 10lbs. cochineal, finely ground,
2lbs. tartar,

5lbs. tin composition,
1lb. oxalic acid,
8 to 10oz. flavine.

Boil together 10 minutes, then fill the dyebath with cold water; enter wool, and heat gradually, and boil for one hour.

For the other lots, keep the same bath, to which add further for every fresh lot:

½ to 1lb. cochineal,
½lb. tartar,
½lb. oxalic acid.

Cochineal reds or scarlet are also dyed on wool previously mordanted with tin composition, or ordinary stannous chloride and oxalic acid, as mentioned before, when giving the different proportions of mordant. Cochineal-dyed wool, when immersed in ammonia or soda solution, will become purplish, and be thus distinguished from reds produced with madder or coal tar colours.

WOOL.

Tin composition for cochineal dyeing is prepared as follows:

10lbs. nitric acid,
10lbs. water,
14ozs. sal ammoniac,

add in small portions at a time, 1¼lbs. metallic tin in thin ribbons. Leave 24 hours, and keep in stoppered bottles for use.

It is also more often prepared by dissolving feathered tin in aqua regia, *i.e.*, a mixture of nitric and hydrochloric acid.

Cochineal is also employed for rose or pinks on a weaker mordant, and without the addition of flavine, which would give a yellow shade.

Cochineal can also be employed on alum mordanted wool, but the reds produced, although faster, are not so bright as with tin mordants.

MADDER.

Madder is still employed to a certain extent in wool dyeing, both as self colour and in combination with other dyewoods, not only for woollen goods, but also for felt hat dyeing, for which purpose it has not been as yet displaced by alizarine.

Red.

On 100lbs. wool.

Mordant for 1½ hours in bath prepared with
14lbs. alum,
7lbs. tartar,
4lbs. stannous chloride solution 50° Tw.

Enter material at 65° C., bring up gradually to the boil, lift, cool, and leave to stand (without washing) for 8 to 10 hours, then wash.

Dyebath.—According to depth of shade, prepared with
36 to 70lbs. ground madder,
and
4lbs. tin solution, 50° T.

When the madder has been properly mixed up with the water, the wool is entered, and the temperature gradually raised so that it reaches the boiling point in 1 to 1½ hours. Boil 10 minutes, lift out, wash immediately.

The proportion given of 70lbs. madder is for a very deep shade; for a medium colour, 40 to 50lbs. will be found amply sufficient. Of course madder can be dyed on iron and chromium mordants, or a mixture of these with alumina.

Of the other natural organic dyestuffs, such as archil, cudbear, etc., also indigo extract or carmine, methods of employment will be indicated in the chapter relating to the explanation to dyed patterns.

ONE DIP DYES.

For several years some special methods have been introduced in wool dyeing, which dispense with the mordanting altogether, since the dyeing is effected in one

bath, and without any special preparation. The majority of wood shades can now be produced by this means.

BLACKS.

Some preparations are sold in commerce for black dyeing, which, under the name of direct black, &c., contain about

2 parts dry logwood extract,
2 per cent. copperas,
1 per cent. copper sulphate.

They are employed by first dissolving in water, acidulated with oxalic or sulphuric acid in sufficient proportion to make a perfectly clear solution.

The method of dyeing is as follows:—

For 100*lbs. Wool*

the bath is prepared with

15 to 20lbs. direct black,

dissolved in acidulated water, when a clear and yellowish solution is obtained. The wool is introduced, and it is heated up gradually to the boil, and kept at this temperature for 1 to 1½ hours. Oxalic acid is the best adapted for this process, but good results may also be obtained with sulphuric acid if great care is taken. Cream of tartar and tartaric acid can also be employed, but are, of course, much more expensive. As for the amount of acid to be employed it is very difficult to give any exact proportions, as it depends to a great extent on whether the water is hard or soft. In ordinary cases, however, with a soft water from 1 to 2lbs. of oxalic acid ought to be sufficient. If too much acid has been employed in the first instance, this can be corrected by the addition of carbonate of soda or ammonia to the bath, until the bath just begins to show a slight turbidity. When the proportions are correct, a fine blue black is produced, and if a jet black is required it is only necessary to add a small quantity of fustic extract. The colour obtained is very intense, does not rub when the operation

has proceeded satisfactorily, and can well be compared with the blacks produced by the ordinary processes in which the goods are mordanted previously.

MORDANT FOR DYEING IN A SINGLE BATH WITH DYEWOODS.

M. Cheneau Fonteneau employs the following mordant for the dyeing in one single bath of blacks, blues, greens, bronzes, etc., and obtains shades that stand fulling well, and also the atmosphere. The proportions are as follows:

Iron sulphate (copperas)	38lbs.
Copper sulphate (bluestone).....	25 ,,
Binoxate of potash.....	30 ,,
Raw tartar.....	2 ,,
Hydrochloric acid	5 ,,

Fast Black on 100*lbs. Wool.*

Boil for 1½ hours with

12lbs. soluble mordant,
12 ,, logwood carmine,
4 ,, fustic carmine,
2 ,, ammonia soda.

After boiling, the wool is taken out of the bath, left to cool, and is then washed. By dyeing the wool previously in the vat, a light shade of

A Fast Blue

s produced with

10lbs. soluble mordant,
5 ,, logwood carmine,
2 ,, soda.

In this latter case the boiling is only performed for 75 minutes.

Blueish Bottle Green.

10lbs. mordant,
10 ,, fustic carmine,
10 ,, logwood carmine,
1lb. soda,

by boiling for 1¼ hours.

Light Green.

10lbs. fustic carmine,
6 ,, logwood carmine,
3 ,, sulphate of indigo,
1lb. soda,
10lbs. soluble mordant, as above.

Fast Bronze.

10lbs. soluble mordant,
15 ,, fustic carmine,
7 ,, logwood carmine,
1lb. soda.

Boil 1¼ hours.

The following mordant is much recommended by French dyers for dyeing in one single bath with dyewood extract :

Alum ..... 1 to 3 per cent.
Binoxalate of potash ..... 3 per cent.
Sulphate of zinc.. ..... 1 per cent.
Copper sulphate..... 2 to 3 per cent.

The following proportions give good results for

Black Dyeing.

12 per cent. logwood extract, 50° T.,
4 to 5 per cent. bluestone,
1 to 1½ per cent. oxalic acid.

Greenish blacks are produced, while with copperas alone reddish or violet blacks are produced, and consequently better results are obtained with both. The best proportions are

Logwood extract, 10 to 15 per cent.
Bluestone and copperas, each 1 to 3 per cent.

The baths may be kept for subsequent operations, when they can be refreshed with more logwood, bluestone, or copperas.

YELLOWS,

with quercitron bark or flavine.

100*lbs. Wool.*

2lbs. flavine or corresponding amount of bark liquor.
5lbs. alum.

Enter wool at the boil, give five turns, lift out; then add

1lb. stannous chloride,

give four turns, wash, etc.

YELLOW WITH FUSTIC.

Although more employed for compound shades, fustic may be employed for yellow dyeing as follows:—

Prepare boiling bath with

10 to 15lbs. fustic extract, 5 per cent.,

give five turns, lift out.

Add—

1½lb. tin crystals,

re-enter wool, give four turns, etc.

SILK.

CHAPTER VIII.

Scouring.—As is well known, silk contains a pretty large amount of gum, and, if coloured, the colouring matter, according as more or less of the gummy substances are eliminated, different varieties of silks are produced, such as ecru, boiled, and souple silk.

Boiled-off Silk.—The ungumming of silk is performed by means of soap solutions, heated to about 90 to 95° C. By boiling the yarns several times in these soap baths, the silk is deprived of its gum or glue, and acquires softness and lustre, but it loses from 28 to 30 per cent. in weight, according to the variety employed.

The soap baths are utilised as much as possible, and then are worked up for the recovery of the fatty acids, by treatment with sulphuric acid. These soapsuds have been found very useful as an addition to dye-baths when dyeing silks with aniline colours.

As a rule, boiled silks are stretched on specially constructed machines, in order to impart to them increased lustre.

The Bleaching is effected also by means of sulphurous acid, by exposure in the wet state to the action of sulphurous acid gas, in the same way as for wool, for about six hours, the operation being repeated several times until a good white is obtained, or with solution of aqua regia, HNO_3 and H Cl.

Souple Silk.—Silk which only loses 5 to 8 per cent. of its weight, and is consequently not completely deprived of its gum.

1st, *Softening:* Work 1 to 2 hours in 10 per cent. soap, 30 to 35° C.

2nd, *Bleaching:* Work for 10 to 15 minutes in stone vessels, containing solution of aqua regia 40° Tw., at 25 to 30° C. Wash well.

Aqua regia is prepared by mixing 5 parts HCl. 32° Tw. 1 part HNO_3, 62° Tw.

3rd, *Stoving* with SO_2 in chamber.

4th, *Soupling:* Work 1½ hours in water, containing 3 to 4 grains cream of tartar per litre. Silk so treated is very well adapted for dyeing.

Ecru Silk is the fibre, deprived of its gum to the extent of from 2 to 5 per cent., by washing or light soaping, and then sulphuring.

Also, in the case of silk, the blueing or tinting is necessary; this is now mostly performed by means of aniline or alkaline blues, indigo extract, or carmine, but principally by means of methyl violet of a very blue shade.

Tussah Silk cannot be bleached in the same way as the other varieties; for this, peroxyde of hydrogen is now mostly used. The fibre, after it has been well cleansed by soaping, is immersed in a solution of the commercial peroxyde (commonly called also hydroxyl), to which a small amount of ammonia is added, until its smell is perceptible, and the silk is left in the bath for several hours, or over night. A quicker and more effective process is to steep the silk into a strong peroxyde solution, and, after wringing out the surplus liquor, to steam it in a cask or suitable wooden box.

SILK DYEING

WITH COAL TAR COLOURS.

The aniline colours are mostly dyed on silk in a soap bath, for which the baths are used which have been originally employed in the boiling off of silk. The acid colours do not require any difference from the basic in their general method of employment, except, perhaps, that a slightly larger amount of acid is used. The soap bath is

preferably acidulated slightly by means of acetic or sulphuric acid. Silk has great affinity for the aniline colours, and the soap bath is only employed to let the dye take evenly, as silk dyed in a bath without the addition of the soap is sure to come out uneven, the colour being precipitated so quickly on the fibre.

The temperature at which the best results are obtained is at 130 to 140 or 150° F., only in special cases is it necessary to go up to the boil, as for instance in the case of azo scarlets. The amount of colour is according to the shade required. The dyestuff is previously dissolved, the solution filtered, and the filtered liquor added gradually to the dyebath. After lifting out of the dyebath the silk is washed, then passed in a new bath acidulated with sulphuric or acetic acid, which brightens the fibre considerably. There is no special remark to offer in the dyeing with the ordinary aniline and azo colours, which will mostly be illustrated by dyed specimens at the end of this work.

The Alkaline Colours.—Alkaline or Nicholson blues are dyed on silk by using a soap bath in which the necessary amount of dye solution is employed along with borax, and the colour is then developed in an acid bath as in the case of wool.

The new class of azo colours, dyeing cotton in an alkaline bath, are so far of interest for silk, that goods of cotton and silk can be dyed in the same bath, and without the aid of any mordant.

ALIZARINE COLOURS ON SILK.

On ordinary iron mordant of 20 to 25° Tw., alizarine gives fast violet and purples, 5 to 10° of the dye-stuffs being found sufficient for a medium shade, while by having a stronger mordant, and increasing the amount of alizarine, deeper shades are produced. It is preferable also in this case, to use soap suds in the dyeing process, to which, however, a small amount of acetic acid must be added.

Alizarine Reds.—Place the boiled silk in an alum bath showing 6 to 9° Tw.; leave 15 to 20 hours, wring and wash, or better pass before washing in bath at about 1° Tw. of silicate of soda. Dye in a soap bath, with the necessary amount of alizarine.

Alizarine Orange is dyed in the same way; on iron mordants it yields reddish violets of browner shade than those obtained with alizarine. With alumina mordant, a bright and fast orange is the result.

Alizarine Blue is fixed on silk by means of a chromium mordant. This is prepared by dissolving precipitated hydrate of chromium, by means of commercial hydrochloric acid, taking care that an excess of the hydrate of chromium is employed to prevent having the bath acid. The chloride of chromium is made up to 20 to 25° Tw., and the silk immersed in the bath for 4 to 5 hours.

Alizarine Brown is dyed on alumina or iron mordants.

Galleine, either on alumina, chromium, or iron mordants; the latter giving duller but faster shades.

Ceruleine, or chromium chloride mordant, 20 to 25° Tw.

Galloflavine, or chromium mordant, gives fancy yellow olive shades, very fast to boiling soap, and of very agreeable tints.

DYEWOOD COLOURS

are not so much used in silk dyeing as they used to be, but they still play a very important part in the dyeing of blacks.

Black No. 1—for 100 lbs. Silk.

1. Boil off and rinse as usual.
2. Iron bath (nitrate or persulphate of iron), wash.
3. Work quarter hour in bath, at 50° C. with
   10 lbs. bark or fustic, or corresponding amount of extract.
   5 ,, cutch.

Heat up to 60° C., then work half hour; lift, rinse, whizz out.

4. New bath

10 lbs. soap.

100 ,, logwood or corresponding amount of extract.

Enter silk at 65°, and bring up to the boil.

5. Brighten in new tepid bath with weak acetic acid.

Black No. 2—on Silk.

1. Wash the silk in weak alkaline solution.

2. Iron mordant, with basic persulphate of iron, 20 to 30° Tw., wring out and wash.

3. Carbonate of soda bath, to fix the iron mordant, wash.

4. Dyeing with yellow prussiate, to obtain prussian blue.

5. Tannin solution with cutch, sumach or myrobolam, according to the quality of the black, which is required at 90 to 95° C.

6. Fixing the tannin by means of stannous solution.

7. Dyeing with logwood.

8. Soap bath.

9. Brightening in acid bath, with or without an oil emulsion.

This series of operations is now generally followed in the dyeing of the best blacks, which are more or less weighted by repeating the iron and fixing baths, as also the tannin and tin fixing baths.

Chesnut extract is employed for the tannin bath for the production of the cheaper blacks. According to Gianoli, in the Italian Journal *L'Industria*, the superiority of the blacks dyed at St. Chamond is due to what had already been maintained before by practical men, namely, the extreme purity of the water, while blacks dyed in Italy do not turn out as bright, on account of the lime contained in the water. Lime forms an insoluble soap on the fibre, which impairs the brightness of the colours. Magnesia would act in the same way.

The method of black dyeing now mostly followed, although varying considerably in the amount of operations, all follow the above principals.

THE WEIGHTING OF SILK.

The weighting of silk, in the process of dyeing, has unfortunately acquired such a hold in the silk industry that it has obtained a recognised position, although, strictly speaking, it is nothing less than adulteration, and consequently a fraud, and cannot any more be defended than can the weighting or charging of cotton or woollen goods, so as to give them a fictitious weight and appearance.

Silks in some cases are charged more than 100 per cent. of their original weight, and in some cases even still more. The thread acquires, besides, a heaviness and size which it did not possess when pure, and is apt to deceive the buyer who only judges by the feel and the appearance.

The charging of silk, which by some is recognised as an art, has been the cause of injuring the prosperity of the industry very considerably, and this beautiful fibre, which in olden time was the symbol of strength and durability, is now-a-days simply the emblem of the hollow and presumptuous show in which this age heartily delights. I do not think that modern chemists need after all be so proud of their achievement in this direction. It must be owned, however, that in recent times attempts have been made to atone, in a certain sense, by introducing methods of weighting the silk which should not be detrimental to the fibre. The methods mostly employed for the purpose rely on the selection of ingredients, according as the silk is white, light coloured, or heavy coloured.

Sugar and glucose were, at one time, favourite products for sophistication, but the weighting cannot be made very high, and, accordingly, these ingredients, although harmless, are not now in favour.

For white and light colours, stannic chloride solution is employed, which is made up to 35—45° Tw., the silks being immersed, lifted out, wrung, and finally washed, being treated in a boiling soap and soda bath; each treatment increases the weight by about 8 per cent., being repeated according to the amount of weighting required. Silks so

charged are easily deteriorated by long exposure to sunlight.

For dark shades, and especially for blacks, the ferric hydrate or peroxide is the weighting mostly employed in the shape of the old and well-known iron mordant, for silk the nitrate or persulphate of iron, which is prepared from copperas by the addition of sulphuric and nitric acid, and has the formula $2\ Fe_2\ O_3,\ 5\ SO_3$. The application relies on the employment of this liquor made up to 45° Tw. or 25° Tw., according as it is a boiled or a souple silk.

After immersing in this liquor for the time necessary to ensure thorough impregnation, the silk is lifted out, wrung, then washed, and finally passed through a tepid soda bath, and soaped at the boil; by repeating the operation every time the weight increases by about ·10 per cent. Silks so charged are generally employed for blacks; the iron charge does not deteriorate the fibre so readily as the stannic chloride, but the silks have a tendency to ignite spontaneously, and this has been the cause of fires on board ships carrying these heavily charged silk goods.

Tannins are also largely used for the weighting of silks, and they do not act so injuriously towards the strength of the fibre as the metallic charges do, but they can only be employed for dark colours. Special tannin products, artificially purified or bleached, have, however, been introduced of late, which allow tannins to be employed even with some lighter colours.

NEW COLOURING MATTERS, &c.

COMMUNICATIONS, ABSTRACTS, &c.

CHAPTER IX.

In this chapter I have included some friendly communications received from different sources relating to new or important dyestuffs, etc., which offer special points of interest to those engaged in the tinctorial arts.

ALIZARINE COLOURS IN WOOL DYEING.

The importance of alizarine and allied dyestuffs for wool dyeing is increasing every year, especially on account of the lower price at which these products can be obtained, and also on account of the fast shades which are produced with this class of colouring matters. Wishing to give the latest and most reliable information on the subject, I have here collected the following particulars, due to the kindness of the Messrs. the Badische Anilin and Soda Fabrik, who, as the first discoverers and producers of these dyestuffs on a large scale, have for years given special attention to the employment of these colours for wool dyeing. I must also thank this firm and their Manchester agents, Messrs. Schott, Sequer and Co., for the fine collection of woollen damasks dyed with the alizarine colours, which have been prepared on purpose for this work.

For wool dyeing, the alizarine and allied products are employed not only on the loose material, but also on slubbings, yarn and cloth, and I understand that the Badische Anilin and Soda Fabrik have put up in their works a complete plant of the system for dyeing loose wool in

order to show practically to dyers the way in which to go about to produce their shades.

The alizarine colours introduced into commerce for wool dyeing are as follows, the dates being indicated so as to form an interesting addition to the history of coal tar colours.

Alizarine (for red)	1878
Alizarine orange	1879
Galleine	1880
Ceruleine	1880
Alizarine blue	1880
Alizarine blue S	1881
Alizarine maroon	1885
Alizarine red S.	1885
Anthracene brown	1886
Galloflavine	1886
Alizarine black	1887

This last product is of great interest, and may have a great influence upon the wool dyeing industry. As is well known, logwood is still the only dyestuff largely employed in the production of blacks, and with the recent introduction of black dyestuffs derived from coal tar, a revolution may be in store at no distant date.

It is an interesting fact to note that all the alizarine colours have the property of forming lakes with metallic oxydes, and, on this property, depends their employment in dyeing. In fact, they are in reality weak acids, which belong to the class of Phenoles.

The principle of the fixation of these dyestuffs on wool, is, therefore, only the formation of an insoluble alizarate on the fibre, or rather of the corresponding salt of the dyestuff with the metallic oxyde, best adapted for the formation of the lake. As for cotton dyeing, the fibre requires to be previously mordanted with the metallic compound, while the dyeing is performed in a separate bath; the difference, however, lies in the nature of the two fibres, which therefore require a different method of application of the mordant. For wool dyeing, the fibre allows the mordanting to be performed in one bath, and by the single operation of the

boiling of the goods, while, as it will be remembered, the process is of a much more complicated nature for the mordanting of cotton. It is also worthy of notice, that the colours produced with the alizarine dyestuffs are not only fast to soap, but stand light well, without mentioning that they stand milling, and to a great extent also acids ; in fact, as far as the latter part is concerned, in some cases they act like acid colours. It will be readily understood that they can be connected with dyewood extracts, and, indeed, any other dyestuffs which are fixed on wool by means of metallic oxydes ; also, when employed mixed with each other, they yield a great number of shades, which can of course be modified by topping them with some aniline or other colours.

The preliminary operations for wool dyeing with alizarine do not differ from those of the other colours, and consequently the *scouring* or washing of wool must be done with the ordinary precautions, either with weak alkalies, or preferably with ammonia, &c.

As far as the *chemical burling or extracting* is concerned, that is the destruction of the vegetable matters generally, which is performed by exposing the wool to dry heat after having been impregnated with sulphuric acid or aluminium chloride, or even hydrochloric acid gas, it must be observed that as the alizarine colours are not affected by these agents, the burling may be performed even on the dyed material.

MORDANTING.

The mordants mostly employed are :—alumina, chromium, iron, and tin salts, which are generally applied in a bath in connection with weak acids or acid salts, by choosing of course the mordant according to the dyestuff and shade required. The acids employed are :—sulphuric, oxalic, or tartaric acids, while for acid salts, acid potassium, oxalate, and tartar are used. As is well known to all dyers conversant with wood colours, tartar is the best, although, unfortunately the dearest agent, especially for the fixation of alumina mordant on the wool fibre.

In mordanting wool for alizarine colours, the same ordinary precautions are to be observed, viz.: that the goods should be first well scoured and rinsed; if the water is too calcareous, this fact must be taken into account by increasing correspondingly the amount of the acid, or the acid salt. It is also necessary that the goods should be boiled sufficiently in the mordant, and, especially that the temperature of the bath should reach as nearly as possible the boiling point as can readily be ascertained by means of a thermometer. Finally, the goods must be well rinsed after the mordant, otherwise, by leaving part of the mordant still loosely adhering to the fibre, the colour produced is apt to rub off, a great drawback with woollen goods which must be guarded against.

MORDANTS.

Chromium mordants.—These are for alizarine dyeing the most perfect mordants, as they produce colours which are perfectly fast against air, light, soap, etc., and when employed with due knowledge and precautions give thoroughly reliable results. The bichromate of potash is the most useful and reliable of the chromium mordants, although the cheaper soda salt can also be employed, if of good quality. The best proportions, found with a water that possessed 10° (German) of hardness, was

3 per cent. bichromate of potash,
2½ per cent. tartar,

the amount of water being

30 to 50 parts for 1 part of wool.

This was, of course, for a full colour, while for lighter shades the amount of mordant is correspondingly reduced.

Sulphuric acid can also be employed for the purpose, but better results are produced with tartar or argol.

Alumina mordants are only employed for the production of reds or orange shades. The proportions most convenient are

6 per cent. alum,
4 per cent. tartar.

The latter must be increased if the water is very hard.

Iron mordants are mostly employed for darkening or saddening purposes after the goods have been dyed on alumina or chromium mordants in the usual way. They can also be employed for mordanting by themselves, but are seldom used for the purpose. The salt mostly used is copperas, although the acetate and nitrate of iron, and even iron alum are sometimes employed.

Tin mordants are principally employed for the purpose of brightening or modifying the other shades. Tin crystals, or tin salt, is the product most conveniently employed, when required for self-colour, which is very seldom the case. The proportions are

3 per cent. tin crystals.
2 per cent. tartar.

The tin salt, however, is principally employed in connection with alumina mordant with the proportions of

6 per cent. alum,
4 per cent. tartar,
$\frac{1}{2}$ per cent. tin salt.

THE DYEING.

The dyeing of wool with alizarine colours is a very simple operation, but it requires a few precautions, foremost among which is that the goods should have been well mordanted and thoroughly rinsed.

The quality of the water also is of great importance, since if the water be very calcareous the lime combines with alizarine, producing a lake which is not of a very brilliant tone, and which, besides, does not possess sufficient fastness. This drawback, however, can be got over by the addition of acetic acid to the dyebath, which prevents the formation of the lime lake. The amount of acetic acid to be employed depends upon the amount of lime contained in the water. The addition of acetic acid to the dyebath is useful, even

when distilled water is employed. For water containing lime to the extent of 10° (German) hardness, 1 litre commercial, containing about 30 per cent. of pure acetic acid, is recommended for every 1,000 litres of water. It is easily to be understood that the material must be thoroughly wetted before it is immersed in the dyebath, or uneven results will be obtained.

The dyeing is started quite cold, or at about 30° C. = 86° Fahrenheit, then gradually heated to the boil, and the goods allowed to boil for two to three hours. This is necessary in order to fix the lake properly on the fibre.

The best results are obtained by dyeing in tinned copper vessels or in wooden dye becks, not so good colours being produced in copper vessels.

MORDANTING AND DYEING

in a single bath. This can be effected in one single bath, but is accompanied by a certain loss of the colouring matter, and consequently is not to be recommended, except in some special instances, such as in the case of alizarine red S., the soluble alizarine sulphonic acid, which gives good results, even if dyed and mordanted in one single bath.

The following details will also be found interesting, as an addition to the history of coal tar colours, and to the chemistry of the alizarine dyestuffs, for which, however, the reader is referred to the volume, by the present author, on the "Printing of Cotton Fabrics." As it is not intended to repeat here, in full, what has already been published on this account, a short notice only will be given of the most saliest points, since it is not the author's intention to enter very fully into the chemistry of coal tar colours, so ably treated by other writers in the English, German, and French languages.

ALIZARINE.

Discovered by Graebe and Liebermann in 1869, the process was given up to the Badische Anilin and Soda

Fabrik the same year, and introduced into working order through the improvements effected by Caro the same year.

Anthracene, according to the now well-known process, is oxydised into anthraquinone, by means of bichromate of potash and sulphuric acid. The anthraquinone is then converted into a sulphuric acid, the latter fused with caustic soda, yields alizarate of soda, from which by decomposition with an acid, alizarine will be obtained. As has been previously mentioned the necessary explanations concerning the modifications of alizarine, flavo, and anthrapurpurine, will be found in the "Printing of Cotton Fabrics,"

The first experiments for the employment of alizarine in wool dyeing were made by the above-named company in 1878, when the artificial product was recommended instead of madder. Later on came the proposal for dyeing alizarine colours on chromium mordants as substitutes for wood colours, principally instead of sanders. Under the generic name of alizarine are, of course, understood the three modifications above named, which give different shades; pure alizarine yields on wool a blueish red, while flavopurpurine gives a red with a yellowish cast, and anthrapurpurine a shade between the two. Of the commercial brands the

W.B.—consists of pure alizarine.
W.R.—mixtures of equal parts of alizarine and anthrapurpurine.
W.G.—anthrapurpurine, and
W.G.G.—flavopurpurine.

With alumina mordant wool can be dyed in different gradations of colours from a blueish to a yellowish red; the shades can also be modified considerably by the employment of tin along with the alumina mordant, when the shades produced are brighter and of a yellower tone.

With chromium mordants reddish brown colours are produced, which, of course, can be greatly modified by the addition of other colouring matters.

In 1878 the firm Przibram and Co., of Vienna, patented a sulphonic acid of alizarine, but the product was not at the time produced on a manufacturing scale. The matter,

however, was taken up again in 1884 by the Badische Anilin and Soda Fabrik, who, having recognised the merit of the product for wool dyeing, brought it into the market under three brands of alizarine S., 2 S., and 3 S., being the sulphonic acids of alizarine, anthra, and flavopurpurine respectively, 3 S, of course, giving the yellowest shades. These products, which are water soluble, give colours which are brighter than those obtained with the ordinary alizarines. They are also more usefully employed on account of their solubility in water for such goods as, being thick, are not easily penetrated all through by the insoluble or sparingly soluble dyestuffs. They also offer the further advantage of allowing the mordanting and dyeing operations to be performed in one single bath. It may be of interest to note that for the production of full shades on wool about 4 per cent. of these soluble alizarine colours will be found useful.

Of the other ordinary alizarine colours (not sulpho products) about 10 per cent. to the weight of the wool is necessary for the production of full shades, the 20 per cent. paste being employed.

Alizarine Orange.

The alizarine orange or β nitroalizarine was first produced on the fibre, by Strobel, in 1875, by exposing goods dyed with alizarine red to the action of nitrous acid fumes. Rosenstiehl isolated the dyestuff from the fibre, and produced it by transferring dry alizarine with nitrous acid. On the other hand, and at the same time while Rosenstiehl's process had not been published, Caro, the well known managing chemist of the Badische Anilin and Soda Fabrik, also based on Strobel's reaction, introduced into practice a manufacturing process which was patented in England in 1876 (No. 1229).

Alizarine orange gives on wool a reddish orange on alumina mordant, while on chromium mordant, a brown red is produced.

The dyeing properties of alizarine orange correspond almost to those of alizarine, with the difference that as the orange is on more acid dyestuff, it is not so easily affected by lime.

Alizarine Blue.

Discovered by Prudhomme in 1877, by the reaction of glycerine and sulphuric acid on alizarine orange. The product of the reaction consists of a mixture of two colouring matters, one giving with alumina mordant, a violet and iron, a greenish blue shade, while the other, with the same mordants, gave brown colours.

These reactions were not further followed up by Prudhomme, but Brunck, a chemist of the Ludwigshafen works, took the matter up, and isolated the blue dyestuff, the alizarine blue, and found out a method for the production of the new dyestuff, which was started on a large scale in 1878. Brunck found further that a soluble combination could be obtained from alizarine blue by combining the same with bisulphites, and thus a new product was introduced into the market, under the name of alizarine blue S., which is recommended in wool dyeing as a substitute for indigo, possessing very valuable properties. The ease and certainty with which it can be applied on wool, combined with an absolute fastness against light, makes this soluble alizarine blue a very useful product for the wool dyer, especially when it is considered that the dyeing in the indigo vat is accompanied by many difficulties, which can only be overcome by means of long experience.

Goods dyed with alizarine blue will not allow of their colour being rubbed off in the same way as those dyed by indigo, an advantage much appreciated when clean goods are required. Alizarine blue can be dyed along with all the other acid dyestuffs, and gives in all respects satisfactory results.

The great drawback that has prevented the employment of this dyestuff in former years was its high price, but since all alizarine colours have been reduced to such low

prices as are now ruling, this difficulty is no more in the way.

In respect of the cost of dyeing with alizarine blue S., the following results may be perused with interest:—Of the three shades, S.W., S.M.W., and S.R.W. paste, which are produced of this dyestuff, 270 grs. were employed for dyeing one kilo wool, which would come to about one shilling per kilo.

The only really useful mordant for alizarine blue is the chromium mordant, for which bichromate of potash, in connection with tartar, is employed; for the latter product, however, tartaric, oxalic acids, or acid oxalate of potash, may be employed. Sulphuric acid does not yield such satisfactory results. Other mordants cannot be recommended for alizarine blue.

When properly dyed, alizarine blue colours on wool are stated to stand light better than indigo blue dyed goods. Against acids also alizarine blue behaves just as well, while it stands chlorine much better than indigo.

The commercial qualities of ordinary alizarine blue are: 10 or 20 per cent. paste, contains the dyestuff in the form of a finely divided pigment, almost insoluble in water, which is especially useful for the dyeing of loose wool.

The water soluble varieties are sold, either in the form of a liquid or as a dry powder. These soluble varieties are to be recommended in the dyeing of very thick goods, which, by their means, are thoroughly dyed all through. They are also more advantageously employed when dyeing in copper vessels, which are somewhat attacked by the paste colour.

Galleine or Ceruleine.

Galleine yields violet colours on wool, which are very fast against light, and stand milling thoroughly well. The violet produced with galleine is not very bright, and consequently this dyestuff is not so much employed for itself, but principally for compound shades. The commercial

articles are in the form of a 10 per cent. or a powder, both sparingly soluble.

Ceruleine, discovered by Bäyer in 1871, at the same time as galleine. Like alizarine blue, the ceruleine is converted into a soluble product by means of sodium bisulphite, and brought in commerce under the name of ceruleine S. It is also best fixed by means of chromium mordants. The shades produced by ceruleine are olive greens of great fastness against light. The principal employment of the dyestuff is also for compound shades. It yields cheaper and faster colours than those produced by means of indigo carmine and fustic.

Anthracene Brown.

Discovered by Seuberlich in 1877, is the result of the reaction of benzoic and gallic acids, when treated with sulphuric acid. The manufacture of this product was started by the Badische Anilin and Soda Fabrik in 1886, on the large scale, after its valuable property of very great fastness for wool dyeing had been properly recognised.

As a self colour, but especially for compound shades, this new dyestuff will be found very useful, and capable of being substituted for many of the older and more complicated methods with the dyewoods. Here again the best mordants for fixation are the chromium mordants, and the resulting colours are perfectly fast against light. In the dyeing operation it must be remembered that anthracene brown is a colour which can only be very slowly fixed on the fibre, and in fact two to three hours' boiling are required for the proper fixation; this is, however, compensated by the fact that the colours produced are much more even than they otherwise would be. The product is brought into the market in paste form, under two marks, anthracene brown W. and W.G.

Galloflavine.

Discovered and introduced by Bohn, in 1886, in the works of the Badische Anilin and Soda Fabrik, by the oxydation of gallic acid in alkaline alcoholic solution by means of air. The commercial article forms a greenish yellow paste. It gives on wool, on chromium mordants, olive yellow shades which stand light and milling. It is found especially useful for fancy mode shades and compound colours, and is recommended as a substitute for fustic.

Alizarine Maroon

Has been produced since 1885, by a secret process, and brought into commerce as a paste. On chromium mordants red browns are obtained which are similar to those produced by means of alizarine. Alumina mordants give light reddish browns with this dyestuff. The dyeing methods are similar to those of the other alizarine colours.

Alizarine Black.

This is undoubtedly the most interesting addition to this valuable class of coal tar colours. It has been recently introduced by the Badische Anilin and Soda Fabrik as a bisulphite derivative of naphthazarine. Both this product and its employment by means of chromium mordant have been the object of recent patents by the above company. For employment in wool dyeing the product comes in commerce under the name of alizarine black S. W., and according to the quantity of dyestuff employed, shades are obtained, varying from light greys to deep black; for the latter 25 per cent. of the dyestuff to the weight of the wool is found necessary. As may easily be conceived, this dyestuff can be employed in connection with the others of the same class for the production of compound shades.

GENERAL REMARKS CONCERNING THE EMPLOYMENT OF ALIZARINE COLOURS IN WOOL DYEING.

Those of the alizarine dyestuffs which are sold in paste form are, as is well known, insoluble in water, but they are in the form of a very finely precipitated pigment, which acts almost as well as if the dyestuff were perfectly in solution. The reason why such dyestuffs are employed in the paste form and not as dry powders is easily understood by the fact that if in the latter form they do not yield the same amount of colouring power as if employed in the paste form. Besides this there would be the possibility of specks being found on the goods by the little insoluble particles. This experience has been gained from the very first time that alizarine was introduced into practice, and consequently the product from the very first has been employed as a paste. It is only in recent times that attempts have been made to use the alizarine in the dry state, and although several patents have been taken, and processes recommended, it does not seem that the employment of these insoluble alizarine powders has been successful. These remarks, however, do not refer to the soluble (bisulphite) alizarine colours, which have become well established in practice for suitable purposes.

When employing paste colours it is necessary to give a good stirring to the contents of the cask, since the alizarine pigment is apt to settle at the bottom.

In keeping the alizarine casks of paste colours it is well not to keep them in too warm places, and in the second instances, when a cask is open, to cover it well, so as to prevent evaporation of the water and drying of the colour, since it is a mistake to suppose that if the dry cake is mixed again with water it will act just as well as before. In all cases it is advisable when keeping casks open for a long time to add now and again the water which has been lost by evaporation, and before used to give a thorough stirring.

The attention of woollen dyers is called to a very interesting property of the alizarine paste, namely, that of

becoming thicker if mixed with acids, while alkalies have a tendency to make the paste much thinner. Consequently, the addition of a small quantity of sulphuric acid may be found useful for the purpose of preventing the paste from settling at the bottom of the casks, and this acidulated alizarine paste would not be a drawback in wool dyeing.

It is also advisable, when adding any alizarine colour in paste form to a dyebath, to push it through a fine hair sieve after it has been well mixed up with water.

It must also be observed that the water-soluble alizarine colours, alizarine blue, and ceruleine powders, must be dissolved in *cold* and not in warm water, and the solution then added to the dyebath through a fine sieve.

The water-soluble alizarine for red S., 2S., and 3S., are better dissolved in hot water.

Water.—The purity of the water has a great influence upon dyeing with alizarine colours. Lime and magnesia form special lakes, with alizarine colours, which would greatly modify the results if the water be too calcareous. There is, however, a simple means of overcoming this difficulty, by the addition of acetic acid to the dyebath.

Apparatus and Machines.—No special apparatus are required for dyeing wool with alizarine colours, other than those generally employed for other dyestuffs. The mechanical dyeing processes, such as those of Obermeyer's, Cerruti Sella, and others, may be employed in the case of the material before spinning.

Dyeing Vessels.—Copper vessels can be employed in the majority of cases with alizarine colours. In some special instances, however, they act injuriously, such as for instance for the dyeing of reds and scarlets, when a small amount of copper will considerably impair the beauty of the colour. In this case, wooden vessels are certainly to be preferred. The copper vessels must also be avoided when dyeing with insoluble alizarine blue and ceruleine pastes, or else the dyeing is accompanied by a loss of the colouring power; this is, however, not the case with the water-soluble (bisulphite compounds) of alizarine blue and ceruleine, which is

undoubtedly due to the corrective action of the bisulphite contained in the colour.

The best results, as far as scarlets and reds are concerned, are achieved in tinned copper vessels, and these latter are certainly to be recommended. The heating, which is done on the Continent by free fire, can be performed in the ordinary way, but preferably by a copper coil, when this metal is not objectionable, or this coil may even be tinned with advantage for reds and scarlets.

DYEING LOOSE WOOL.

Chromium Mordant.—For 100*lbs. Wool.*

3lbs. bichromate of potash,
2½lbs. tartar,

each dissolved separately, and then added to dyebath. Bring in, 1½ to 2 hours to the boil; lift, cool, rinse. If well mordanted the wool will have acquired a light greenish colour, which must be either yellowish or whitish.

For very hard water take

4lbs. bichromate,
3 to 3½lbs. tartar.

Dyebath.—Temperature, 25 to 35° C., the colour is added by following the precautions pointed out before, that is, the insoluble are mixed up with water, the soluble are dissolved in cold water, and then wrung through a fine sieve into the dyebath, which is of course well agitated. Then add further for every 100 gallons water, 1lb. acetic acid; by very hard water use instead 1½ to 2lbs. acetic acid. Enter the wool, work ¼ hour cold, heat gradually, and bring up to boil in ½ hour. Boil 2 to 3 hours to fix the colour properly on the fibre. Goods so dyed only require a slight rinsing to be perfectly clean.

Alumina Mordant.—For 100*lbs. Wool.*

6lbs. alum,
4lbs. tartar,

for brighter and yellower shades, add further
½ to 1lb. tin crystals.
Mordant and dye as mentioned before.

VARIOUS NEW DYESTUFFS.

Brilliant Crocein, M. and 9B., which also are derivatives of the gama disulphonic acid of beta naphthol, discovered by Leopold Cassella and Co. The brilliant croceines have more affinity to the fibre, and therefore give deeper shades than the crocein scarlet made with beta naphtholmono sulpho-acid, and for this reason greater care must be taken not to add too much alum to the dyebath.

Milling Red, G. and B. are azo colours, which possess a remarkable resistance against alkalies; they stand a fair milling, and white wool being milled together will not be stained in this process; of course if the milling be exaggerated, these colours will recede as well as any other. The mark G, if dyed on silk, stands washing perfectly well.

Archill Substitute, produced by nitrodiazobenzol and the naphtholmono sulpho-acid, possesses the valuable quality of setting slowly on the fibre, and combines with almost all colours dyeing in a sour bath to uniform shades, and therefore deserves its name. It is indeed a practical substitute for archill.

Cotton Brown and Diamin Red belong to the class of colours dyeing cotton without mordant in an alkaline bath Cotton brown is very fit for mixed shades. Diamin red is the bluest of those reds known commonly as direct colours, and is at the same time a most brilliant dye.

Naphthol Black, B and 4B, important for felt hat dyeing, produced by combination of diazonaphthalin sulpho-acid with naphthol sulpho-acid. These products dye animal fibres, especially wool, a fair black. The colour dyes evenly in an acid bath, resists washing, and is very fast to light.

Neutral Red—New Blue, B and R.—The neutral colours are produced by the action of nitrosodimethylamin upon

metadiamin. The different isomeres give red to blue products—neutral red made from toluylendiamin. In close connection with the neutral colours stand the new blues, of which the two typical shades, R and B, will be found illustrated in the pattern sheets, but nine different marks are manufactured, all of which are different in shade. This group of dyestuffs has the advantage of dyeing cotton very easily, and being fast to light, especially the new blues.

Scarlet 6R.—The first azo colour, which has been put in the market in perfectly pure crystals, produced from diazonaphthalin, and the gama disulphonic acid of beta naphthol, a very rich, brilliant blue shade scarlet.

Naphthol Green is the fastest to the influence of light of all existing tar colours. It is dyed in a sour bath, to which the addition of a small quantity of sulphate of iron is very advisable. The colour obtained appears a bright green in artificial (gas) light, whilst the same shade produced in any other way seems brownish in artificial light. For this reason this dyestuff is specially recommendable for billiard cloth.

Proportions for 100*lbs. Wool.*

5lbs. dyestuff,
5 ,, copperas,
10 ,, glauber salt,

in acidulated bath.

CASSELLA'S NEW BLUES IN NEUTRAL COLOURS.

Cotton: Method of dyeing 100*lbs.*

Dissolve in order to obtain full shades—

3lbs. of colouring matter in 15 gallons of boiling water,

with addition of some muriatic acid; stir well until all is dissolved.

Boil the cotton well, leave it 4 to 5 hours, or better over night, turning from to time in

1st bath tepid, containing—

5 to 10lbs. tannin, or the proportional quantity of sumach, and

2½ to 5lbs. acetic acid at 8 deg. Tw.

Wring well; leave the cotton 1 hour, turning frequently in

2nd bath cold, containing—

2½ to 5lbs. tartar emetic,

or a good quality of oxalate of antimony, wash and dye in

3rd bath containing the necessary quantity of colouring matter and

1 to 2lbs. muriatic acid.

Enter at 90° F., raise temperature to the boil. (The bath will be completely exhausted). Brighten if necessary with a weak solution of muriatic acid.

Preserve the baths 1 and 2, adding for further use one-half or even one-third of the quantities of mordants used for the first operation.

Where the use of antimony mordants is excluded

Stannate of soda at 1½ deg. Tw.
or Pinksalt ,, 2½—3 ,,
or Perchoride of tin ,, 2½—3 ,,

is recommended, of which stannate of soda is the best, but antimony mordants give faster shades. If no fastness to washing is required, 100 parts of alum with 15 parts of carbonate of soda at about 4° Tw. may be used; in this case give no acid to the dyebath.

MILLING RED G AND R.

Wool is dyed in a hot sour bath (sulphuric acid and glaubers salt). The dyeings not being influenced by a previous chrome-mordant, these products can be recommended for mixtures with vegetable dyes.

Silk is dyed in an acidulated soap-bath; silk dyeings with milling-red G do not let the colour go in water, and even withstand hot soap.

These dyestuffs are also very suitable for printing on wool and silk, giving shades fast to washing.

PREPARING SOAPS FOR WOOL SCOURING.

Many wool dyers and bleachers prefer to prepare for themselves the soap employed in the scouring process, and, consequently, I have thought it useful to give some directions thereon, which I am enabled to do by the kindness of Mr. Menzies, of the Greenbank Alkali Works.

POTASH SOAP FOR WOOL SCOURING.

50lbs. Greenbank caustic potash.
50lbs. weight (5 English galls.) of water.
190lbs. of tallow.

Break up the contents of a 50lbs. can, by first striking it all round, on the outside of the can, with a hammer. Pure caustic potash is packed in solid blocks in cans, it being impossible to prepare it in a powdered form, like pure caustic soda, it being so much more deliquescent an article. Now open the can and empty the contents into an earthenware or iron vessel, with 5 gallons (50lbs. weight) of water. Stir, and the potash dissolves almost immediately, heating the water. Let the lye thus made cool until just warm to the hand (say about 80° F). Melt 190lbs. of tallow or grease, which must be free from salt, and let it cool until fairly warm to the hand (say 120° F). Now pour the caustic potash lye into the melted tallow, stirring for one or two minutes with a wooden stirrer, until both are thoroughly mixed and smooth in appearance. This mixing may be done in the pan used to melt the tallow, or in a wooden tub, or an oil barrel. Cover up well and put away in a warm place for two or three days (stirring again the second day to thoroughly remix) during which time the mixture saponifies. This gives about 290lbs. of highly concentrated potash soap. For making liquid soap for use in an ordinary wool washing machine, it should be dissolved in five or six times its weight of water, with a small quantity of refined carbonate of potash added.

There is no difficulty about mixing much larger batches than the above of *potash* soap, as the saponification is effected more easily than with soda soap. For instance, a drum of potash of about 800lbs. can be dissolved at once in 80 gallons (800lbs.) of water, and mixed with 3,040lbs. of melted tallow.

For simple wool washing cottonseed oil, if cheaper, may be substituted for tallow, otherwise there is no advantage. On no account, however, must cottonseed oil be used for making a soap for washing finished goods, or for milling purposes, on account of the unpleasant smell that a cotton-seed oil soap leaves in them.

POTASH SOAP FOR FINISHING FINE GOODS, OR FOR MILLING PURPOSES.

50lbs. of pure caustic potash.
50lbs. (5 English gallons) of water.
200lbs. of clean well rendered tallow, free from salt.

Made just in the same manner as the previous soap, but should always be kept for two or three weeks in a dry room before it is used, thereby improving the quality.

For fine washing purposes with delicate colours this is the very best and purest soap that can possibly be obtained. Olive oil may be substituted for tallow, and makes a most beautiful soap, but it is more expensive. If this olive soap be re-melted in the proportion of two pounds of soap to one pound of water, a fine clear soap will be obtained. No boiling is necessary—just heating sufficiently to thoroughly mix the water and soap together.

GAMBINE.

I owe to Messrs. Read Holliday and Sons the following instructions for using their new patented product: In all cases the gambine should be mixed with three or four times its weight of cold water before adding to the dye-bath.

Brown.—Gambine 20 to 30lbs., mix as above with water, add to the bath, and bring the temperature to boiling point, enter 100lbs. of jute, and work for a quarter of an hour. Then add 3lbs. bichrome, and work for another half hour.

Brown Olive—.Proceed exactly as for brown, and then add 2lbs. of sulphate of iron (copperas) to the bath, and work the jute for a quarter of an hour longer.

Green.—Gambine 20 to 25lbs., mix with cold water, add to the bath, and bring temperature to boiling point, enter 100lbs. jute, work for half an hour, then add 5lbs. sulphate of iron (copperas), and work for another quarter of an hour.

Combined shades are obtained as follows: First dye the jute with gambine, and fix with bichrome or copperas, as above, then add 2lbs. of bisulphate of soda (nitre cake), and then acid mauve or claret red, or other azo or acid colour; quantity of colour to be regulated according to shade desired. The colours are fast to light and washing.

Instructions for dyeing loose wool, wool yarns and cloth: In all cases the gambine should be well mixed with three or four times its weight of cold water before adding to the dyebath. Wood vessels should be used, iron in any form having a tendency to green the shades produced.

Browns.—The material to be dyed is first prepared by boiling about one hour in a bath containing for each 100lbs. material 3lbs. bichromate of soda (or potash) and 1lb. tartar; or if very red shades are required, take 4lbs. bichrome and 1lb. sulphuric acid (some prefer oxalic instead of sulphuric acid). If only light shades are required no acid need be used with the bichrome.

Wash off well after preparing.

Then dye in a bath containing from 1 to 30lbs. gambine, quantity to be regulated according to depth of shade required; heat up to boil, and dye like logwood, for half an hour or more.

Gambine R. gives red browns and gambine Y. yellower shades, when prepared as above.

Olives.—Olive shades are obtained by proceeding in the above manner and then saddening to shade with sulphate

of iron (copperas) The longer in this bath and the more copperas used the greener the shade.

Greens.—100lbs. material is prepared with 3lbs. sulphate of iron and 2 to 3lbs. of tartar, well washed off and then dyed with gambine in another bath, in the same manner as for browns, only the sulphate of iron is used instead of bichrome. If the wool is afterwards boiled with bichrome the shade can be turned to an olive.

The shades produced by gambine are very fast to light, and a variety of shades can be obtained by combining with alizarin, logwood fustic, redwood, yellow N., claret red, acid mauve, milling red, and other colours.

The alizarin, logwood, etc., can be added to the same bath as the gambine.

SERIES OF COLOURS FOR REDS, ORANGES, AND YELLOWS.

From Messrs. Brooke, Simpson, and Spiller, Limited, I have received the following particulars concerning a new series of colours for producing various shades of red, orange, and yellow of great fastness. The ingrain red, the most important of the series, compares favourably with turkey red as regards fastness to milling, scouring, acid and other tests, but is not so fast against light.

Primuline.—This yellow colouring matter is the starting point for all the shades belonging to the new series. It is easily soluble in boiling water (free from acid). For wool and silk work at a boil, in an acidulated bath, wash and dry. It will also dye wool or silk well from a neutral or slightly alkaline bath containing common salt. For cotton and mixed goods, cotton and wool, or cotton and silk: work at a boil in a strong bath with a good quantity of common salt, wash and dry. No mordant whatever is required. The addition of soda crystals to the bath when dyeing mixed goods diminishes the affinity of the colour for the wool or silk, but increases it for the cotton; a small quantity of acid has an opposite effect.

Ingrain Red.—To produce this shade on wool, cotton, or silk, dye the goods yellow with primuline as above, wash and pass through a cold bath containing about one or two ounces of nitrite of soda to every gallon of water, smartly soured with oil of vitriol. Wash again well, and develop the red by passing the goods through a cold or warm bath, not above 100° Fahr., containing about a quart of "red developer" to every 10 gallons of water. When fully developed wash and dry. The nitrite bath must be cold, and must be freshly made; it will not keep more than a day, but the developing bath can be used repeatedly if about 2 or 3 quarts of developer are added for every 100lbs. of goods dyed. After passing through the nitrite of soda bath, the goods should appear of a golden orange shade, and the developing must at once be proceeded with, or the colour will decompose and the red will not appear.

Ingrain Orange.—Proceed as for red, but use the "orange developer." Dyed on wool, cotton, or silk, these colours stand milling and scouring; are free from bleeding, and acids do not affect them. They dye cotton without any mordanting whatever; mixed goods, both cotton and wool, or cotton and silk, are dyed at one operation, and without the cotton being mordanted or prepared. They act as a mordant for all the basic colours, such as bismarck brown, meldoline blue, roseine, hofmann or methyl violets, malachite green, safranine, &c., &c., so that an immense variety of shades can be obtained from them. By mixing the orange and red developers intermediate shades can be produced.

STIBINE.

The following particulars are due to Mr. Dupee, of Walpole Dye and Chemical Works, near Boston, Mass., U.S.A.

Stibine is a perfect substitute for tartar emetic or oxymuriate of antimony, and is superior in every way to oxalate of antimony. It is used precisely the same as tartar emetic, pound for pound, and at the low price at which it is

sold will show great advantages over the latter article, as a single trial will prove. Use from 1 to 5 pounds stibine to 100 pounds goods, as a light or dark shade is desired. At first a difficulty was experienced in dissolving the stibine, as it had a tendency to cake with age. But these disadvantages have now been overcome by improvements in the manufacture, whereby an article is produced that is perfectly pure, being free from iron or other metallic substance injurious to colours. Stibine has special advantages over oxymuriate of antimony, as it gives more brilliant shades and a regular bath can be kept, while with the oxymuriate of antimony the bath grows acid by standing, and not only injures the shades but tenders the goods. In fact, wherever a metallic mordant is needed in connection with any tannin matter, such as extract of sumach, nut galls, myrabolans or tannic acid, stibine will be found very valuable. This mordant is equally adapted to the use of raw cotton, cotton yarn, or warp dyers, calico printers and silk dyers.

BLACK MORDANT.—No. 1.

For fast Milling Black on Raw Cotton at one operation.—The black made with this mordant on raw cotton is the best milling black that can be obtained. It is easy to colour, and is obtained at a single operation. The black, in richness of shade, softness, and milling, equals the best black on wool; and the cost is less than of that produced by many of the old methods.

FAST YELLOW D.

For Cotton, Silk, Wool, Jute, &c.—This dye gives a rich shade of old gold on all kinds of animal and vegetable fibre, without the aid of a mordant, and at one operation. It dyes easily and evenly, and produces shades remarkable for their fastness to light, milling with soap and alkali. In conjunction with logwood, a great variety of rich shades of olive may be obtained. Fast Yellow D is particularly

useful for dyeing cotton flannels, cotton warps, silk noils, and raw cotton for mixing with wool.

SALUFER, THE NEW ANTISEPTIC.

Salufer is the trade-mark name for a substance, sodium silicofluoride, found by Mr. William Thomson, F.R.S. Edin., of Manchester, to be a powerful antiseptic. It has the advantage of not being volatile, so that when mixed with size it does not evaporate from it. It is a much more powerful antiseptic than chloride of zinc, 1 part of this substance being equivalent to about 14 parts of chloride of zinc in its power of preventing mildew. A very small quantity, therefore, of this substance is required to prevent mildew and decomposition in goods in which it is introduced. From 1 to 1½lbs. of salufer per cwt. of ordinary dry flour or starch is all that is required.

Salufer is not easily soluble in water, a gallon dissolving about 1 ounce when cold, and about 3 ounces when hot. It is not poisonous.

CUDBEAR AND ORCHILL.

These two dyewares are prepared from Orchella weed by oxidation with the addition of an alkali. Cudbear is a dark-red powder, and orchill a liquid or paste. Both are made in two shades, one red and the other blue, to suit the preferences of dyers. These dyes are seldom used for self-colours, but are largely employed in dyeing compound shades, especially with indigo. The colouring matter (orcein) contained in them gives best results when a neutral bath is used; but the addition of a small quantity of acid or alkali does not affect its dyeing properties, except that acids redden the shade and alkalies turn it bluer. Wool and silk are readily dyed by cudbear and orchill without the aid of mordants; but they do not dye cotton, and this circumstance is taken advantage of in testing for purity. The patterns shown among the others on the pattern

cards are dyed without mordants. These details are due to the kindness of Messrs. J. Marshall, Son & Co., who have also supplied the corresponding patterns, having had them dyed on purpose for this work.

THE HERMITE BLEACHING PROCESS.

Some progress has been made during the last few months in the development of this electrical bleaching method, which, as is well known, depends upon the employment of magnesium chloride. Opinions are still rather conflicting, being very favourable on one side and equally unfavourable on the other. While awaiting for further improvements before forming a decisive judgment in the matter, it seems to me that the inventor and his co-operators have already achieved a certain amount of success in some special applications. From information received, it appears that the method has given good results in manufacturing trials on the large scale for linen bleaching and also for paper pulp.

My opinion is that the electrical method of the preparation of bleaching solutions to be immediately used for bleaching of vegetable fibre will be the method of the future. The following particulars are taken from a pamphlet kindly sent me by Messrs. Patterson & Cooper, the electrical engineers who have devised the plan and tried the method in connection with M. Hermite :—

The process is based on the following operations :—

When an aqueous solution of magnesium chloride (consisting of 5 per cent. of magnesium chloride, and 95 per cent of water) is electrolysed in a suitable apparatus, this salt is decomposed at the same time as the water.

The nascent (*i.e.*, newly liberated) chlorine of the magnesium chloride and the nascent oxygen of the water (resulting from the electrolysis) unite at the positive pole, and produce an unstable oxygen compound of chlorine of very high bleaching power. The hydrogen and the magnesium go to the negative pole; this last decomposes the water and forms magnesium oxide, whilst the hydrogen is dis-

engaged. If in this liquid coloured vegetable fibres be introduced, the oxygen compound acts on the colouring matter, oxydising it; chlorine combines with the hydrogen to form hydrochloric acid, which, finding itself in presence of the magnesia in the liquid, combines with it and forms the initial chloride of magnesium. Thus a complete cycle of changes goes on so long as the electric current acts on the solution in presence of colouring matter. The cycle is a perfect one, in which there are four elements—the electric current, chloride of magnesium, the water, and the colouring matter. Only two of these elements are used up in bleaching the colouring matter—the electric current, or, what is the same, the motive power and the water. Thus the chloride of magnesium serves over and over again. There is only a simple displacement of molecules, and the chlorine acts as a vehicle to discharge the nascent oxygen on the colouring matter.

It will be asked, Why employ magnesium chloride in preference to any other chlorides of the alkalies or alkaline earths? The reply is, because the inventor of the process has found out, after prolonged research, that it is magnesium chloride which of all these chlorides gives the most practical and most complete results.

M. E. Hermite was the first to demonstrate—

1. That in the electric decomposition of chlorides in solution there is a special and peculiar oxygen compound of chlorine formed at the positive pole, and not merely chlorine gas, as has hitherto been supposed, or hypochlorites, produced by the combination of this chlorine gas, when liberated with the alkali formed at the negative pole.

2. That magnesium chloride is the salt that gives the best results from an economical point of view.

It is stated above that the bleaching liquor obtained by this method has a bleaching power greater and more rapid than that of ordinary bleaching powder. It is easy to demonstrate this fact by the following experiment:

Take two equal volumes of a fresh solution of bleaching powder and of the electrolysed magnesium chloride. These

two solutions are to be of the same degree of strength of nascent oxygen, as tested by the arsenious acid method. Add the same weight of the vegetable fibre to be bleached to each solution, and it is seen that the bleaching proceeds much more rapidly in the electrolysed solution than in the solution of bleaching powder; but what is more remarkable is, that if the two samples are allowed to bleach to the same degree of whiteness, the electrolysed solution has only lost about half the oxygen strength of that of the bleaching powder. Thus to arrive at the same colour, there has been required much less oxygen with the new process. This fact has been verified in numerous experiments, with all sorts of vegetable fibres. It has also been verified that the fibres undergo less loss of weight by this method than with the ordinary process with bleaching powder.

INDUSTRIAL APPLICATION OF THE PROCESS.

The installation varies according to the arrangement of the bleachworks, but it is established on the following general principles:—

The ordinary plant of the works is not interfered with. The storage tanks, where the bleaching powder is usually stored, are filled with a solution of magnesium chloride of specific gravity of 1.022, or containing 2½ per cent. of anhydrous magnesium chloride, and these tanks are connected with the electrolysers by means of pipes, so that the solution can circulate, with the aid of a pump, between the tanks and electrolysers till it is raised to the right degree of bleaching strength. The solution is then conveyed into the ordinary bleaching tanks, or potchers, but instead of being allowed to exhaust itself, it is constantly pumped back into the main reservoir in connection with the electrolysers, so as to maintain a constant strength.

The material being bleached to the required degree of whiteness is taken out and pressed or drained. All the liquid obtained in this way is carefully pumped back into the reservoir to be electrolysed afresh; the only loss being

that retained mechanically in the material, which cannot be squeezed out, and even this loss can be reduced by a proper system of washing of the fibre. The plant consists of:

1st. One or more Dynamos.

2nd. One or more Electrolysers.

3rd. The pumps and pipes for circulation.

Measuring instruments are also supplied, indicating the work done by each apparatus.

The size of the plant is calculated so as to replace the amount of bleaching powder in daily use.

COCHINEAL CARMINE.

The method of production of this beautiful pigment is even now kept a secret, and it will, therefore, be interesting to peruse the following particulars, which I owe to the kindness of M. Horace Koechlin, who has discovered the method after very many trials:—

25 litres C.
75 c.c. S.
2½ kilos acetate of soda.
125 c.c. tin salt solution at 100grs. per litre.

The whole is left to boil, then filtered, and the precipitate washed.

Yield obtained:—100grs. dry carmine

C.

250 grs. Cochineal powder.
10 litres water.
50 grs. cream of tartar.

Boil 1 hour and filter.

S.

1 kilo sulphate of alumina.
2 litres water.
½ kilo soda crystals.

With the mother liquor of the manufacture of carmine (after the precipitate has been separated by filtration as above) tin lakes can be obtained which will be found useful in wool printing and for other purposes.

To the same gentleman I owe the following particulars concerning the dyeing of

BLACK WITH DINITROSORESORCINE:

1st, mordant the cotton in tannic acid solution at 20 grs. per litre, or of sumac extract at 40° gr. per litre. Leave goods to stand on heap without drying and without washing until next day, then wash. The goods are next passed in the bath N., left to stand again on heap, then washed, when they are ready for dyeing with—

2 grs. dinitrosoresorcine paste.
2 ,, alizarine orange.
2 ,, gallocyanine.
5 ,, calcium chloride 20° bé

for every 100 grs. of tissue.

Dye in one hour up to 70° C., allow to remain half an hour at this temperature, then wash and dry.

Bath N.

½ litre water
½ ,, nitrate of iron
⅛ ,, white glycerine
½ ,, soda
⅛ ,, pyrolignite of iron, 10°

Of this liquor 1 litre is mixed with 3 litres of water in making up the bath.

With this latter, Nankin shades can also be produced by simply passing the goods through the bath more or less diluted with water, and leaving the goods to stand a little while before washing.

PRODUCTION OF ANILINE OIL AND SALT.

Dr. Dreyfus, of the Clayton Aniline Co., has communicated to me some interesting details concerning the amount of aniline produced in their works. The firm started 12 years ago with a production of 30 tons per month, and are now

producing 100 to 110 tons per month of aniline oil and aniline salt combined, comprising a nitrification of 900 to 1000 gallons pure benzol or toluole for aniline or toluidine manufacturing. The firm prepare their own nitric acid, and purify their benzol and toluol as well. This aniline production is very likely the largest in the coal tar colour industry.

BENZIDINE COLOURS.

These direct colours have been fully described in another part of this work. The following additional information is abstracted from a lecture by Hurst, before the Society of Dyers and Colourists, at Bradford, February 25, 1888.

DYEING COTTON WITH

Hessian Purple, Hessian Violet.—3 per cent. colour, 10 per cent. common salt; boil for half an hour, then rinse in bath of carbonate of soda.

Azo Blue and Benzoazurine can be dyed on cotton also in bath of borax or 5 to 10 per cent. Glauber salts.

Hessian Yellow.—Same as Hessian purple, or with addition of a small amount of alizarine oil.

The dyebath is kept at 150° F., since a higher temperature will redden the yellow.

Chrysophenine and Brilliant Yellow.—Dyebath prepared with 20 per cent. salt, 2 per cent. acetic acid, besides necessary amount of colour. Temperature of dyebath to be kept at about 150° F.

Alkalies or soap would redden this yellow.

FOR WOOL DYEING.

These colours have only lately been applied, the necessity of using an alkaline or neutral bath having been against their employment.

The *Congoes* are best dyed in a boiling bath with salt and a little potash.

The *Hessian purples, violets* and *yellow, brilliant yellow* and *chrysophenine,* must be dyed in a bath with salt and at a *boiling* heat for half an hour to an hour.

These colours go very well on to wool, with which, very likely, they enter into chemical union.

The *benzopurpurines, delta-purpurines,* and *roseazurines* can be dyed in a bath acidulated with a little acetic acid, but a neutral or even slightly alkaline bath is preferable.

Chrysamine is dyed in the same way.

Azo blue, azo violet, benzoazurines, and *heliotrope* can be dyed in an acid bath with acetic acid.

It is a notable fact that the shade produced by all the blue and violet colours of this class on wool is much redder than that on cotton.

On wool the colours are universally faster to light, air, and acid than on cotton. They perfectly withstand the operations of milling or fulling, and are therefore suitable for using in mixed goods.

For goods of woollen and cotton these colours can be used; in the case of the Congoes, purpurines, roseazurines, chrysamine, the dyebath should be made with 2 per cent. of potash and 10 per cent. of phosphate of soda; the cotton and wool both take the same shade.

In the case of the Hessian colours no difficulty is experienced, the bath for wool is the same as for cotton; the violet, however, will require a little alkali blue adding to the bath to ensure the colour of both wool and cotton being even.

Azo blue, azo violet, benzoazurine, heliotrope, all dye wool a redder shade, especially if acetic acid is used in the bath for these colours; a bath with phosphate of soda is best for mixed wool and cotton goods, with the addition, if necessary, of a little alkali blue.

These colours yield, on wool, shades which stand soaping well, and do not soil the whites if woven together.

As regards fastness to light, it has been proved that the colours are uniformly faster on wool than on cotton. The

yellows and blues are hardly affected. The reds are the most fugitive, and they are all darkened to a more or less extent, the Congo and Congo 4R and most benzopurpurines; Hessian purples rank next, followed by the brilliant Congoes and delta-purpurines, which are the fastest of these colours.

PARAPHENYLENE BLUE.

The following information I have obtained from Mr. Theodore Bang, the agent for Messrs. Dahl and Co., of Barmen. The product belongs to the group of soluble indulines, and is distinguished by great fastness against light and air; likewise against alkalies generally, and soap; it also stands acids well.

For cotton dyeing, the goods are mordanted with tannin or sumac and antimony mordant in the usual way.

The dyebath, in which the necessary amount of solution of the colour has been added, is started at about 25° C., and then gradually brought up to 80° C., while the goods are worked.

After the dyeing it is advisable to pass the goods in an oxydizing bath, which helps very considerably in the fixation of the colour on the fibre. For the purpose either the bichromate of soda, or potash, or chlorate of potash, or even iron perchloride may be taken, but the bichromate will be no doubt found mostly employed.

The oxydation might be performed in the same dyebath, but this is not to be recommended, as it is better to keep two separate baths. About 1 to 1½ per cent. of bichrome is employed for the oxydation, and the bath is employed pretty hot. The fastest shades are produced when a thorough oxydation has taken place; in this instance, however, the brightness of the colour is somewhat impaired, which, however, is not always a disadvantage, as, for instance, in the case of imitation indigo blues, which are produced by taking a larger amount of bichrome in the oxydizing bath. By topping the blues with other coal tar colours a great variety of shades may be produced.

The paraphenylene blue is also employed for wool dyeing, and is found useful in the dyeing of mixed wool and cotton goods, for which purpose it will be found useful, especially as the cotton can be dyed first, and on account of the colour standing acid, the wool can afterwards be dyed in an acid bath.

Silk can be dyed with the product as usual in an acidulated soap bath.

The colouring matter is soluble in water. It is brought into commerce in three different shades, R, B, and Y.

To dye a full shade on cotton 2 per cent. dyestuff is sufficient, while 0·2 per cent. bichromate of potash is sufficient for the oxydation.

RHODAMINE.

This beautiful pink dyestuff, introduced by the Badische Anilin and Soda Fabrik, is one of the most recent discoveries of coal tar colour chemistry, and forms a welcome addition, as it yields, especially on wool, shades which unite with great brilliancy the desirable property of a fastness superior to that possessed by other eosine colours.

The product is obtained by the action of sulphuric acid for 3 to 4 hours at 180 to 190° temperature on anhydrous-phtalic acid, and the chlorhydrate of meta amido phenol. The dyestuff, which is consequently phtaleine, is soluble in water, and as it dyes cotton on acetate of alumina or tannic acid and antimony mordant, it may be considered as a basic dyestuff.

Wool is dyed either in a slightly acidulated bath with sulphuric acid and glauber salt, or simply in a neutral bath. In this latter case brighter shades are the result.

Silk is dyed in the usual way in a soap bath slightly acidulated.

Curiously enough, the colours dyed on cotton with rhodamine do not stand light so well as those obtained on wool, which show a very fair amount of fastness.

CHINA GRASS, OR RHEA-RAMIE FIBRE.

It was the author's intention to devote a chapter to the important question of the utilisation of this fibre, especially in regard to its extraction and separation from the stems. The mass of matter already on hand in the present volume, however, has prevented this, and, in order to fulfil the promise made in another part of the work, the different methods or processes employed or recommended will here be very briefly mentioned.

I.—For the separation of the bark from the stem:

(a) A Death and Ellwood machine working on green stems which are pushed against a revolving beater that breaks the woody part of the stem. A powerful jet of water, adapted so as to play under the stems, helps in removing the broken wood and washing the raw fibre which is thus produced.

(b) Separation by hand:

When stems are quite freshly cut the bark can be readily separated from the woody portion by hand.

When the stems have been standing for some time, the bark adheres more strongly to the wood, and cannot be so easily separated by hand. In order to effect this separation, the steaming of the stems has been proposed for 15 to 30 minutes in a wooden box (Favier's process).

According to the author's numerous experiments, a short boiling of the stems in a carbonate of soda or caustic soda solution will allow of the bark being removed very easily by hand. For fresh stems about 5 to 10 minutes are sufficient. Even dry stems can be decorticated in this manner by boiling them for 20 to 30 minutes.

When the bark is well separated from the wood it contains all the fibre, none being left on the wood. Green stems can be kept without undergoing fermentation by immersing them in a solution of a bisulphite or of sulphurous acid, as the author has recommended as the result of his experiments. Several machines are on the market for effecting the separation from green or dry stems, among others those

of Berthet, in Rouen, and of the Ramie Française, at Avignon.

The fibre can also be separated from the woody portion by treating the stems when dry on suitable machines, which, however, in some cases are apt to injure the fibre and occasion loss by filaments adhering to the wooden pieces.

But stems that are very dry can easily be worked by these machines, as the wood becomes brittle. One method recommended consists in exposing the stems in a stove to a moderate heat, and then scutching them.

II.—The bark, when separated by hand and thoroughly dry, yields a fibre capable of being spun without difficulty on the ordinary flax machinery, and this would be the simplest method. The difficulty, however, lies in the drying of these barks or ribbons containing the fibre, and also in the amount of hand labour required for this decortication.

As will be seen, there are many methods recommended; but, in spite of this, even now the question of the industrial application of the fibre is far from having reached that point of advancement which might be expected. But no doubt a great future is in store for this fibrous material.

To those interested in the question I beg to refer to the pages of the *Textile Manufacturer* for 1885-6-7, where a series of articles on the subject will be found embodying my lectures in Bradford, before the Society of Dyers and Colourists, and in Manchester, before the Society of Chemical Industry. Also articles will be found which comprise all that has been published on the subject in the last few years, among which are some investigations on the dyeing of the fibre by M. Blondel, of Rouen, and a very practical and interesting letter from Mr. Taylor Burrows, of Lille (May, 1886, page 217).

MORDANTING WOOL AND WOOL DYEING.

Several papers of investigation and practical experience on this subject have been read before the Society of Dyers and Colourists, at Bradford, among which may be mentioned one by Wilkinson, on chromium mordants, and one by

Topper, on the application of logwood in wool dyeing (May number, page 70, of the Journal of that Society, for 1886). It had been my idea to insert in this volume an abstract from these lectures, but as it is not possible to do for want of room, I beg to refer all those interested to the papers on the subject contained in that Journal, reproduced in the *Textile Manufacturer* and other technical publications. Articles on the investigations of Liechti and Suida are also of great interest to wool dyers and colourists generally.

MACHINERY EMPLOYED IN DYEING.

CHAPTER X.

FOR COTTON.

Up to a few years ago very few establishments have made use of dyeing machines, or machines generally that would do away with the hand labour, except, perhaps, in turkey red dyeing, where, for many years, special machines have been employed for mordanting, washing, etc. But of late years the prices obtained for the dyeing of cotton yarns have descended to such a low figure that it has become a question of very great importance to treat large quantities at once, and by mechanical means, so as to reduce the labour charges to a minimum, and consequently different machines have been introduced into practice, some of which bid fair to become very useful for large dyeing establishments. Of course, the dyeing of warps by mechanical arrangements, imitating those used in cloth dyeing, has been in actual use for many years, especially for such colours as blacks, indigo blues, etc., which, being produced on a very large scale, made the employment of machinery quite imperative.

The mechanical arrangements for the dyeing of the cotton fibre generally, which are now being introduced into practice, rely on different principles. Some inventors begin with the beginning, that is, start altogether with the loose cotton, the fibre before spinning, and there is no doubt that the principle is right, although there are two difficulties in the way, one being that of the penetration of the colours all through the mass, when large quantities are operated upon.

Another difficulty is, that in some cases the spinning is made, to a certain extent, more difficult by the cotton being dyed; but neither of these two drawbacks is an insurmountable barrier, and it is now a question at which stage the dyeing had better be performed, on cotton just from the bale, or after it has undergone a certain amount of opening and cleaning. The latter is certainly preferable, and we have seen many inventors following this plan, by dyeing the cotton in the sliver, while some others go farther and dye it in the cops. The methods are various, and it cannot be said that any one of them has so far established itself as a general method of application, but some of the manufacturing trials made on the large scale with some of these processes have been very encouraging. For the dyeing of loose cotton, the same apparatus can be used as is now being successfully employed for loose wool, and which has been mentioned before. There is, without doubt, a very wide and promising field for inventors of processes for dyeing the cotton fibre in large quantities at a time, either before spinning or after.

NEW MECHANICAL PROCESS FOR DYEING COTTON OR WOOL IN THE SLIVER.

The following particulars, with the accompanying illustrations, have been taken from a pamphlet issued by the Patent Process Dyeing Company, and kindly sent to the author by Messrs. Ely Sutcliffe and Son, of Mirfield, Yorkshire:—

"The process, as applied to cotton, begins at the cotton card coiler, and it will be best understood when described with reference to the accompanying drawings, wherein Fig. 15 is a sectional view of a machine suitable for use in the dyeing of cotton sliver, parts of the machine not necessary to the proper illustration of the invention not being represented in the drawing. Figs. 16, 17, and 18 illustrate the formation of the package of sliver which is to be treated in the apparatus illustrated in Fig. 15. For convenience of

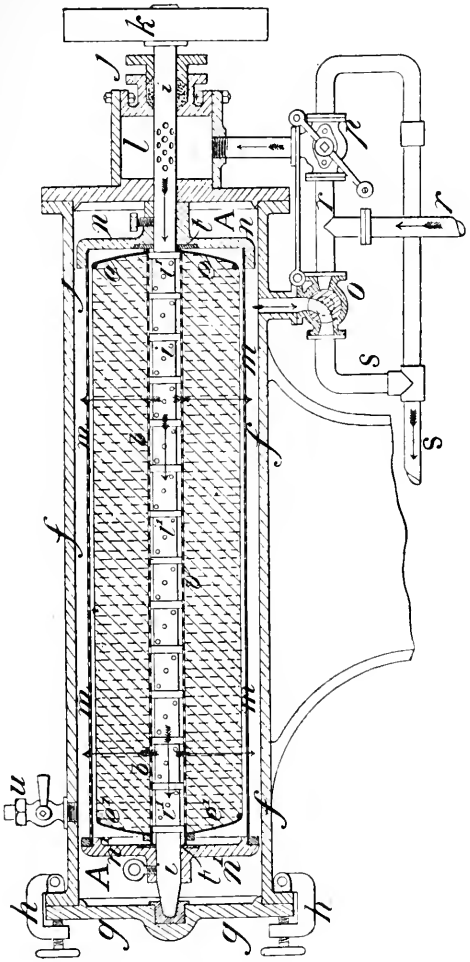


Fig 15.

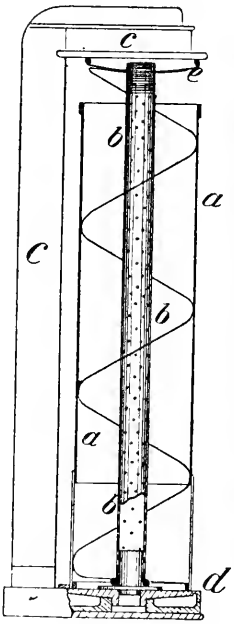


Fig. 18.

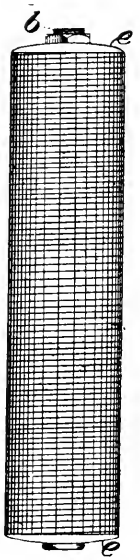


Fig. 16.

Fig. 17.

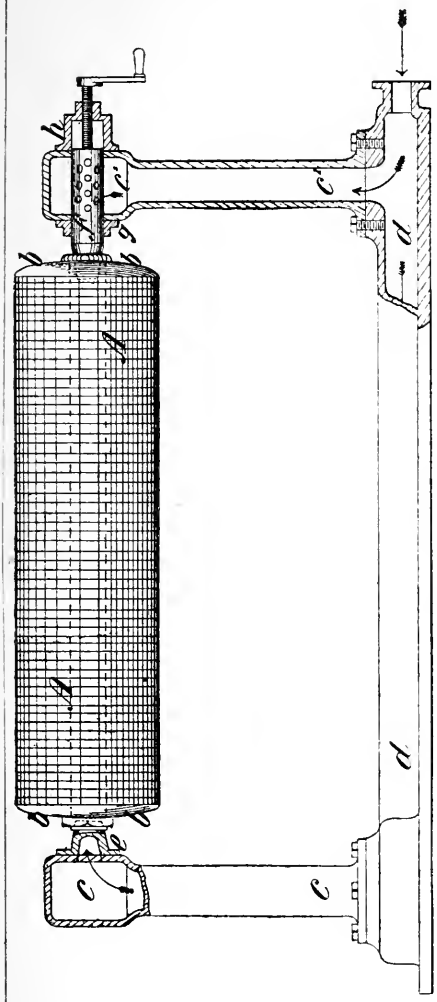


Fig. 19.

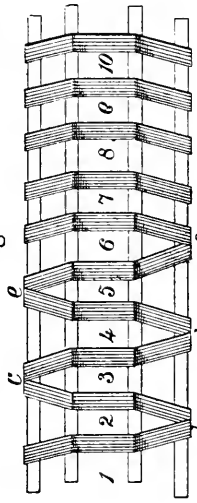


Fig. 20.

description we will refer in the first place to the drawings in Fig. 16 representing the said package of sliver. Fig. 17 represents a cross section of the same, and Fig. 18 illustrates the method of formation of such package. In the latter figure *a* is a can which is the same as an ordinary coiler can, with the exception that it is not provided with a fast bottom, *b* is the perforated tube, and *c* is the ordinary coiler of the carding engine. The can *a* rests upon a plate *d*, which is provided with a stump upon which is placed the perforated tube *b*, the said stump keeping the tube in an upright and central position within the can. The can is provided with a spiral spring as usual, and upon this spring is placed a dished plate *e*, which receives the coiled sliver, and slides down the perforated tube as the sliver accumulates. The sliver is coiled around the tube in the manner indicated in Fig. 17. When the can is full it is lifted off the coil and a second dished plate e^1 is placed upon the top of the mass and is forced down by means of a nut which is screwed upon the end of the perforated tube. The coiled sliver is thus formed into a bobbin shaped package resembling the indication in Fig. 16, the plates *e*. e^1 forming end flanges which keep the sliver from escaping from the tube. In Fig. 15 the said package is represented in position within a chamber A, which in the example is supposed to be of a cylindrical form, but the formation of the said chamber may be varied. The shell or casing *f*, in which the said chamber is formed, is provided with a removable door or cover *g*, which is secured by means of clamps *h*, or by other suitable means. Within the said chamber is mounted a hollow shaft *i*, one end of the shaft being seated in a step or bearing in the door *g*, the other end passing through a gland *j* to the outside, and being provided with a belt pulley *k*. Between the said gland and the chamber A is a smaller chamber *l*, and the portion of the shaft which crosses this latter chamber is perforated, so that any fluid which may be forced or passed into the chamber will flow into the space within the tubular shaft, and will pass out through other perforations into the main chamber A, or on the contrary, fluid forced

into the latter chamber will flow into the chamber *l*. The portion of the shaft which is within the chamber A is provided with collars i^1, which are of a diameter to suit the bore of the aforesaid perforated tube *b*, so that the space between the shaft *i*, and the interior of the said tube is divided into a number of small annular-shaped isolated chambers. Each of these chambers communicates with the bore of the shaft by means of a perforation or slot, or of two or more such openings, and these are so proportioned as that the stream of fluid shall be equally divided amongst the said annular chambers, so that there shall be an equal flow into all the said annular chambers. The perforations in the tube *b*, which is within the package of sliver, are preferably numerous and small, and are evenly distributed throughout the length of the tube. The shaft *i* is provided with a cylindrical cage *m* to receive the package of sliver, the said cage being made of perforated sheet metal or of wire gauze. The said cage is connected with the shaft by means of ends *n* n^1, the former being permanently secured to the shaft and the latter being removable, but being capable of being secured by means of a screw or other suitable means. The chamber A is connected by means of a branch, with a two-way cock *o*, and the chamber *l* is connected with a second two-way cock *p*. The plugs of these cocks are connected together, so that they work in unison when a handle upon one of the plugs is operated upon. When the two plugs are turned in one direction passages are opened for the flow of fluid through the pipes *r* and the cock *p* into the chamber *l*, and thence into the chamber A, and for the flow out of the chamber A through the cock *o* into a pipe *s*. When the cocks are reversed the direction of the flow of the current is also reversed, the fluid then flowing through the cock *o* into the chamber A, and through the cock *p* out of the chamber *l* into the pipe *s*. When the machine is used in the dyeing of sliver the two pipes *r* and *s* are connected with a cistern vat or reservoir of dye liquor, the pipe *r* withdrawing liquor from the cistern, and the pipe *s* returning liquor to the cistern. In practice a pumping apparatus

of any ordinary or suitable description is interposed between the dye cistern and the cocks, so that the liquor can be forced into the chamber A, The pipes *r* and *s* or the pipe *r* alone are also connected with a water supply pipe, adopting suitable cocks or valves for shutting off communication with the dye cistern, and opening the passage for the flow of water at the required times, but it has not been considered necessary to show these appliances in the drawings, as they may be of an ordinary description. The manner in which the apparatus is used may be described as follows. The package of sliver is by preference enclosed within a bag envelope or wrapper of cotton cloth, flannel, wire gauze or other suitable material to protect the sliver which appears at the outside of the package. This having been done, the package is introduced into the cage, the tube *b* sliding upon the hollow shaft *i*, and the cage end n^1 is placed upon the shaft, pushed up tightly against the package and secured. The two cage ends are provided with elastic washers or packings at *t*, *t*, to prevent the fluid from flowing out of or into the hollow shaft without passing through the package of sliver. The door *g* having been shut or placed in position and secured, the dyeing operation may be commenced, but preparatory to the treatment with the dye liquor we in some cases pass water through the package, the shaft *i* being revolved or not as preferred. A vent cock *u* is opened to permit air to escape from the chambers. The dye liquor is then forced through the pipe *r*, the package being revolved and the liquor passing, say for example, into the chamber *l* through the shaft, and the package of sliver into the chamber A, whence it passes into the pipe *s*, which conveys the liquor back to the dye vat, or it may be conveyed to a second vat to be re-inforced with dye. After a time the cocks are reversed and the liquor then passes directly into the chamber A. and through the sliver into the shaft *i*. These reversals are caused to take place at frequent intervals during the operation. The revolution of the mass of fibres during the flow of the dyeing liquor tends greatly to the even distribution of the

liquor throughout the mass of fibres, because the liquor is caused to pursue a lengthened curved course instead of merely passing radially in straight lines through the mass. The said revolution also tends to prevent the liquor from principally following lines of least resistance, that is to say, from passing to too great an extent through the parts of least density. The combination of the reversing of the direction of the flow of liquor and the rotation of the package of sliver has still more important effect in conducing to the production of uniformity of result and evenness of shade. When the dyeing operation has been conducted for a suitable period the supply of dye liquor is stopped and the chamber is drained. The package of sliver is then revolved more rapidly in order to discharge as much as possible of the dye liquor remaining within the mass of fibre. A counter shaft or any suitable driving gear may be employed to impart the varying speeds to the shaft *i*. The dye liquor having been sufficiently discharged, if desirable water is passed again through the package to rinse out the remaining unfixed dye, and the package is rapidly revolved to drive out the excess of water. This ability to discharge the contained dye liquor or water, as the case may be, is an important feature, as not only is there a saving in dye liquor, but there is a great saving in the time required to dry the fibres, and there is greater uniformity of shade owing to the fact that less coloured or discoloured water is left in the mass to be dried out of the same, and thereby to leave irregular deposits of matter in the fibres."

"The package of sliver may then be removed to the drying machine. All methods of drying consist in causing the water contained in the material to evaporate into the atmosphere. The usual method adopted is the application of heat, as it is a general law that the greater the heat the more rapid the rate of evaporation. Heat is, however, very injurious to many textile fibres, especially when it exceeds the boiling point. It is impossible to make all parts of the material completely dry at one time, and, consequently, the parts that are dry first become too dry before the others are

dry enough, and we find as a result that after stoving, fibrous materials are very much reduced in strength.

"The method here preferred is to dispense with heat, and to obtain a rapid evaporation by passing ordinary atmospheric air rapidly through the material; in this manner the evaporation is quite as quick as the method of stoving, and does not in any way injure the fibre.

"In Fig. 19 is represented an elevation, partly in section, of the drying apparatus, and it also shows a package of sliver as when undergoing the drying treatment. A represents the said package, which we will suppose has been produced by coiling around a perforated tube *a*, flanges *b b* having been applied at the two ends of the package.

"In Fig. 19 *c c*^{1} are two air pipes which are connected together by means of an air conduit *d*, which conveys air from a Root's blower, or from a suitable blowing apparatus. The air may be at a normal temperature or be warmed, as preferred. The pipe *c* is provided with a fixed nozzle *e*, which is coned so as to enter one end of the perforated tube which is within the package. The other pipe *c*^{1} is also provided with an air nozzle, but in this case the nozzle is made adjustable in directions toward and from the other nozzle, in order that the package of sliver may be readily placed in and removed from the position represented in Fig. 19. The nozzle *f* is fitted to slide in a bored pap *g* upon the pipe, and is provided with a screw, which works in a nut in a second pap *h*. By turning this screw the nozzle can be slid toward the package, and be caused to enter to some extent into the end of the perforated tube *a*, and be pressed into the same, so as to make a sufficiently air tight connection. If preferred, both nozzles might be adjustable. When the package is thus mounted in position the air blast enters the tube *a*, and passes through the perforations in the said tube into the sliver, through which it passes in all directions from the tube to the outside of the package, where it escapes, carrying with it an amount of moisture taken up from the sliver. Although only one package appears in Fig. 19, it will be readily understood that by

making the air pipes c c^1 suitably long they may each be provided with more than one delivery nozzle, so that two, three, or more packages of sliver may be undergoing the drying treatment at the same time, the air pipes c c^1 being made suitably large in cross section, or being supplied with air at two or more points in their length.

"In this manner the drying can be effected much quicker than by the ordinary process of stoving, and without the slightest injury to the fibre.

"When the drying process is complete the central perforated tube can be withdrawn, and the sliver put into an ordinary coiler can, and taken direct to the drawing frame.

"It has formerly been found much more difficult to work dyed cotton than when worked in the grey, especially in dry, frosty weather, but this was when the art of dyeing was much less understood. Of recent years some of our best dyers have overcome this objection in a very simple and economical manner.

"Cotton always works best when it contains a certain per centage of moisture, and when in its natural state it usually retains this degree of moisture, even in the hot spinning room, by virtue of its hydroscopic properties. These hydroscopic properties are due to potash and other salts which cotton contains, and which, having a great affinity for moisture, are the means of preventing the moisture from being entirely removed from the fibres. In dry frosty weather, however, even cotton in its natural state is found more difficult to work, because then these salts are not sufficient to resist the intensely dry atmosphere. When cotton is dyed these salts are dissolved out, and, if left so, the fibres become too dry to be worked.

"It is this dryness that gives rise to the troublesome electrical phenomena which have been observed in the working of dyed cotton.

"The electricity is caused by the friction of the dry fibres over each other while being drawn in the machines; when the fibres have their natural moisture it acts as a conductor to convey the electricity away.

"The cause of the difficulty only needs to be recognised to at once suggest the remedy, and efficient dyers now wash off with a solution of the proper salts, and thus give back to the fibres their natural hydroscopic properties.

"It will be easily seen that in this process liquors can be made to circulate through the material at any temperature and in an infinite variety of directions. The process is, moreover, a purely mechanical one, and is devised to reduce the expenditure of hand labour, and to prevent any waste of dye liquors by extracting in the same machine and conveying the liquors back to the bath.

"The fibres are not in any way injured either by the dyeing or drying, and the trouble of having the dyehouse filled with steam is entirely removed.

"It is evident that the dyeing machines can be made of any size and to hold any quantity required; they have been made hitherto of a size to suit the coiler at present in use, so that they are applicable to the existing trades.

"It must be remembered, however, that though they are small, their power of work is very great, the time required for dyeing is very much reduced, and the machines can be packed so closely together. Although the above description is confined to the consideration of textile fibres, and more particularly cotton in the form of slivers, it must not be understood that the process and apparatus are suitable only for sliver.

"Anything that can be put in the form of a rope or ribbon, and coiled in the manner described, can be dyed by it.

"Warps can be dyed in this way, and in fig. 20 a plan is given of tying hanks into a long string on the reel so that they can be coiled and dyed by this process. After the hanks have been tied on the reel in the usual way, every alternate two are tied together, then the reel turned half a revolution, and each alternate two tied together at that point, taking care that the two tied together are not the same in one as in the other; thus the hank No. 1 is tied to hank No. 2 at *b*, hank 2 to hank 3 at *c*, and hank 3 to hank

4 at *d*, and so on. In this way the hanks come off the reel in one long string, and are coiled round a tube by an ordinary coiler.

"This method of dyeing hanks by tying them together has been tried before by passing them through warp-dyeing rollers, but it was found that the parts of the hank where the tie was were a different shade to the rest. This defect does not arise where the hanks are coiled, as the connecting string does not grasp the hank tightly as in former methods, and puts no more stress on the hank than the threads of the hank do upon each other.

"The process is also applicable to the dyeing of textile fibres in the raw state. It can likewise be adapted for dyeing yarn on the beam."

MACHINERY EMPLOYED FOR COTTON YARN DYEING.

FOR BOILING OR SCOURING.

Large establishments employ kiers of low or high pressure, just on the same principle as those employed in the bleaching of cotton cloth, and illustrated in Plates I. and II.

Plate III. shows an arrangement of cisterns for bleaching.

Plate IV. shows a hydroextractor or whiz, an apparatus now always to be found in all the best works, and which does away with the wringing by hand.

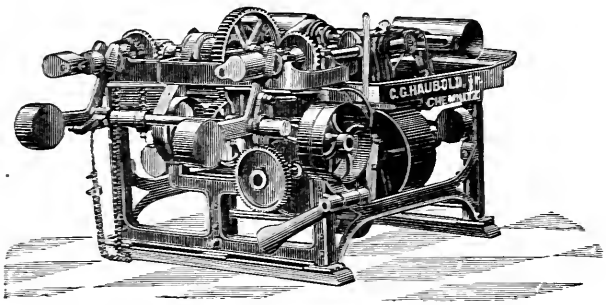
Plate V. shows the principle of a circular washing machine, which has been for years successfully employed in turkey red dyeworks.

Plate VI. illustrates another principle of a washing machine, which is also used for the soaping of yarns, and in fact constitutes an open soaper for yarn.

MORDANTING YARN.

Fig. 21 shows a machine mostly used in turkey red dyeworks on the Continent for the mordanting of cotton yarns.

The hanks, after having been impregnated with the mordant by passing through a basin containing the same, and being squeezed between two cylinders to allow the liquor to penetrate well, are wrung by a special arrangement devised on the apparatus.



YARN MORDANTING MACHINE.—FIG. 21.

DRYING.

Special attention has been given in the last few years to the drying arrangements for cotton yarns in order to effect the drying of large quantities, and the Plates VII., VIII., IX., and X. illustrate different apparatus devised for the purpose, Plate XI. being designed for the drying of warps.

Of these apparatus, the one shown in Plate VII., by Pierron and Dehaitre, is constructed to work on a continuous principle, and, as seen from the illustration, the hanks enter on the left hand side through the lower part of the machine. The yarn is put on sticks or bars, and then placed by the workman on the chain working in front of the apparatus; the hanks then travel from the lower part to the higher portion of the machine, first in a vertical, then in a horizontal position, and, coming out at the top quite dry, are taken off from the chain. The drying is effected by a current of hot air which comes from the top, and goes through the drying chamber or chest in a direction opposite to that followed by the hanks. The current of air is produced by

an aspirating ventilator placed at the bottom of the machine, as shown in the illustration.

The air is heated by passing through a series of pipes placed at the top part of the chamber, and heated by steam or other means.

The bars or sticks on which the hanks are laid are themselves exposed to a rotatory motion.

A machine of this system, 5 metres in length by 3·50 metres in width and 4 metres in height, is capable of drying from 1300 to 1400 kilos. in 11 hours.

The machines shown in Plates VIII. and X., by Haubold, are also designed for the rapid drying of cotton yarns. In the first instance the hanks are placed on bars fixed on frames, which in their turn are fixed on a common central axis, by means of which they are made to revolve. The apparatus is enclosed in a room, and the air is heated from below by a series of pipes, which are, however, not shown in the illustration.

The drying machine shown in Plate X. works by a current of hot air, and is supplied with an exhauster or ventilating machine.

Plate IX.—Messrs. Mather and Platt's hank drying machine—works in a continuous manner by passing the hanks spread out in their full width, and bound together, end to end, by suitable coupling links, as shown in the illustration.

DYEING MACHINE FOR HANKS.

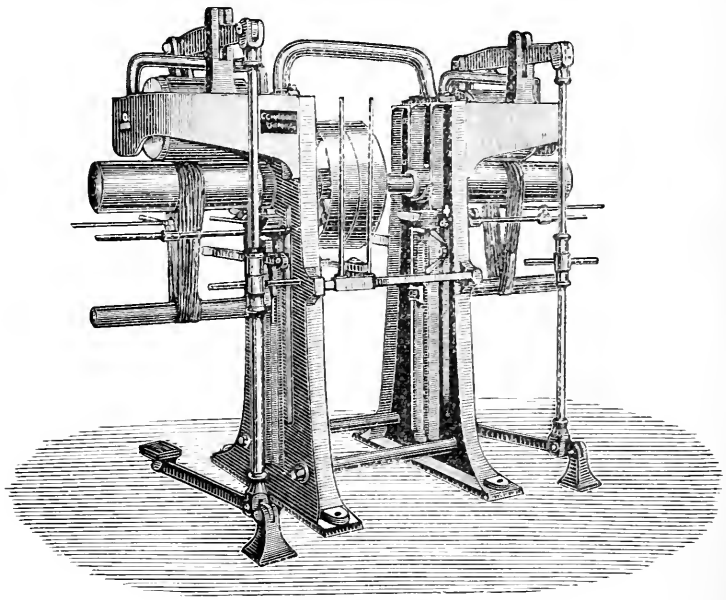
A rather large number of hank-dyeing machines have been patented in the last few years, and some of them introduced into practice in different works. The great extent of the cotton yarn dyeing industry, and the lowering of prices in the dyeing of cotton explain why so many efforts are being made to reduce labour to a minimum in this industry. Among the numerous machines, figs. 1 and 2 on Plate XII. show the principle of the Robertshaw's apparatus, fig. 2 on Plate XIII. being the sizing and

wringing machine. Corron's dyeing machine is shown in Plates XIV. and XV.

Robertshaw's machine consists of a system of porcelain reels revolving on their axes, the hanks being hung on these reels, and made to revolve in the dyeing liquor. The reels are fixed together on a common frame in such a way that they can be bodily lifted from the beck, or sunk in order to let the hanks fish in the liquor. On one side will be found the wringing arrangement for the hanks.

Plates XIV. and XV. show Corron's dyeing machine, which has attracted considerable attention of late, and, like the other one, was shown at the Manchester Exhibition, 1887. It consists of a long dyebeck, to which is applied a suitable frame, on which moves backwards and forwards the central arrangement coming at the top of the beck, which is plainly visible, especially on Plate XIV.

By this arrangement each stick (which is made square for the purpose, and is especially constructed with a wooden



YARN FINISHING MACHINE.—FIG. 22.

frame attached to it) is seized and lifted up, and in so doing the stick is turned, and the yarn with it, on account of the frame attached to the stick. The yarn is then immersed again when the stick has reached the other side of the arrangement, after describing the movement of an arc or semicircle. Every stick is being worked in turn; every hank is consequently turned. The working arrangement moves from one side of the beck to another and back at will, and thus the dyeing is proceeded with.

These machines for yarn dyeing are being more and more introduced into dyeworks. It must, however, be owned that handwork, so far, still holds its own for the majority of purposes.

After dyeing, cotton yarn is often subjected to a process of *finishing* or *sateening* by passing the hanks between two cylinders, which, by pressing on one another, give a certain bright look to the fibre. Fig. 22 illustrates a yarn finishing machine.

THE POLISHING OF COTTON YARN

is really a branch of the sizing of cotton. It is performed by impregnating the hanks with a composition of starch or flour paste, china clay, and paraffin wax, and then stretching the hank spread over two cylinders of the polishing machine, where it is exposed to the action of revolving brushes, which dry the yarn and impart to it a high degree of brightness or polish. A yarn polishing machine, the illustration of which is due to Haubold, is shown on Plate XVI.

MACHINES EMPLOYED IN THE BLEACHING AND DYEING OF COTTON CLOTH.

THE MATHER'S BLEACHING PROCESS.

The following particulars, with the corresponding illustrations, Plates XXXV., XXXVI., XXXVII., of most recent arrangements for the bleaching process for cotton cloth, have

been abstracted from a series of articles in the Italian journal, *L'Industria*, of Milan, as reproduced in the *Textile Manufacturer*.

The illustrations show the plant as at present arranged in the establishment of Messrs. E. de Angeli and Cie., of Milan, where the steaming scouring process with caustic soda has been lately introduced, and the older plant modified to suit the improved conditions of bleaching.

Plate XXXV. is the plan of the arrangement of all the apparatus on the ground floor capable of bleaching 50,000 to 60,000 kilos calico per week. The apparatus being put down is as follows :—

F, steamer kier already put down.

F, steamer kier shown in dotted lines is space left for another.

C^1, centrifugal pump.

f, *g*, *h*, cistern for caustic soda lyes.

P, *g*, platforms and rails for wagons.

V, V, wagons for pieces.

U U, cisterns for pieces.

M M, N N, ordinary boiling circulating kiers, with injectors used either for lime or soda boiling in the old process, or for heating the water for the new method.

E, roller washing machine for alkaline bath.

D, squeezers.

C, washing machine also used for alkaline bath.

B, machine for acid bath.

X, hydro-extractor.

A, washing machine.

G, chlorinating.

H, roller machine for acid bath.

I, roller machine for washing bleached pieces.

Y, squeezing machine for bleached pieces.

L, squeezing machine.

P, Q, R, S, depositing cisterns.

The bleaching operations in Messrs. E. de Angeli and Cie's establishment are as follow :—

1st, washing on machine A.

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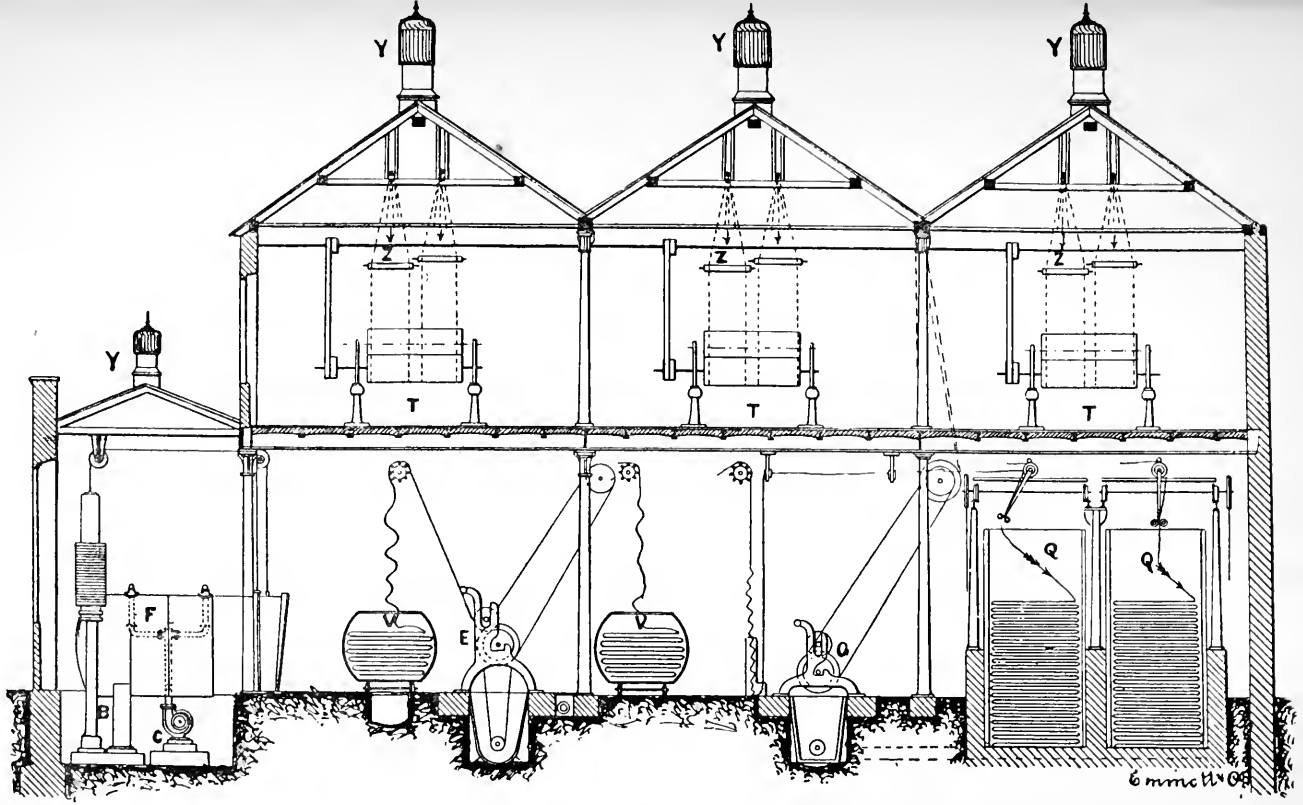

PLATE XXXVI.—MATHER BLEACHING PROCESS.—TRANSVERSE SECTION.

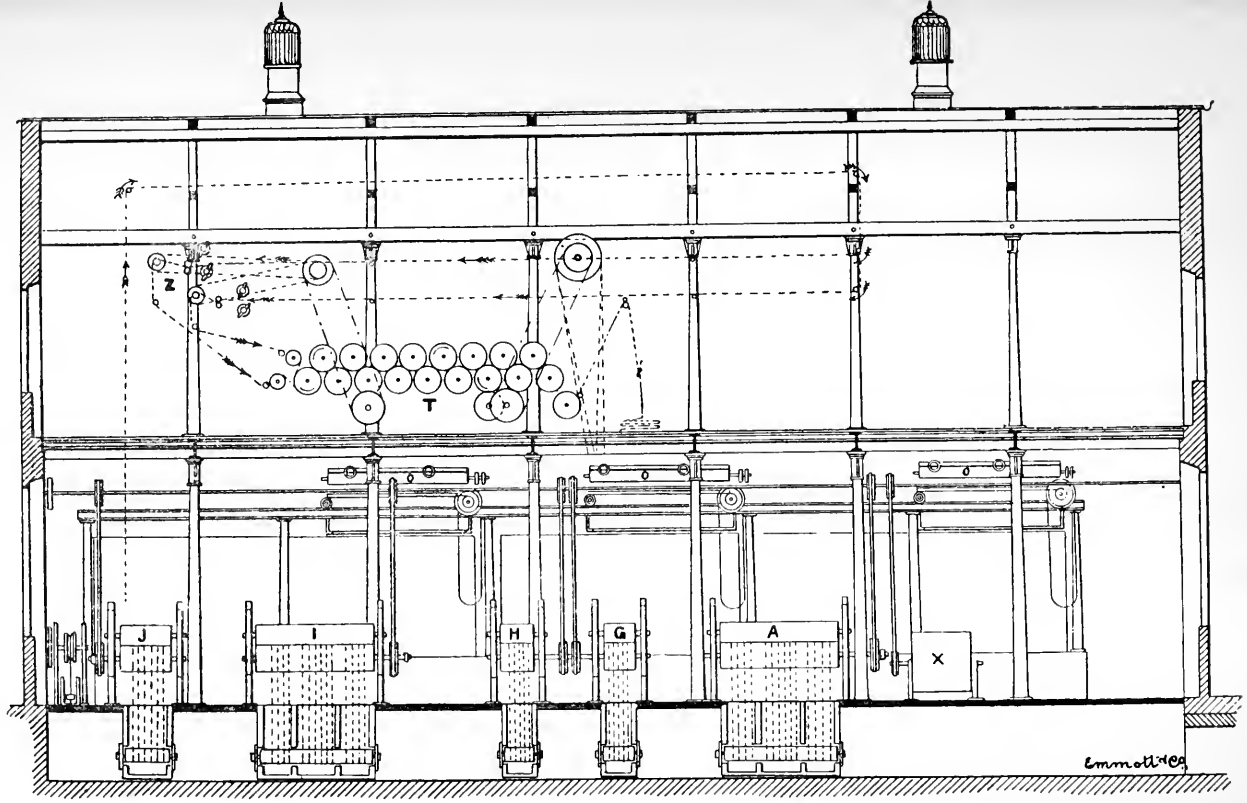

PLATE XXXVII.—MATHER BLEACHING PROCESS - LONGITUDINAL SECTION

There is beside the saving of time a great saving of chemicals, labour and coal, so as to render it one of the most important improvements introduced in the last few years in the bleaching of cotton cloth.

DYEING MACHINE FOR COTTON CLOTH.

The dyeing machines for cotton dyeing have not undergone any marked change in the last few years. They may be divided into two principal classes, one working one or two pieces at a time, as the jigger, and the other the proper dyeing machine as employed in alizarin dyeing (see the "Printing of Cotton Fabrics").

These machines are too well known to require description, and only the illustrations are shown in this work.

Plate XVII., jig winch.

Plate XVIII., dyeing jiggers.

Plate XIX., jiggers of French construction.

In some cases special machines are employed, as for instance in indigo dyeing, where iron oblong tanks are employed, supplied with a system of rollers to compel the cloth to pass through the vat; the process being conducted in a continuous manner.

Dyeing machinery for black dyeing will be found described on page 86 and following pages.

Of other apparatus employed in the treatment of cotton cloth, three among the now very numerous systems of washing machines are shown in Plates XX, XXI., and XXII.

Plate XXIII. illustrates a hydro-extractor for heavy goods, principally velvets, &c.

Plate XXIV., cylinder drying machine.

Plate XXV., stentering and drying machine.

THE FINISHING OF COTTON GOODS.

The important question of the finishing of cotton goods could not be found space for in a work of this description. It is, in fact, a subject that requires a volume of itself, and

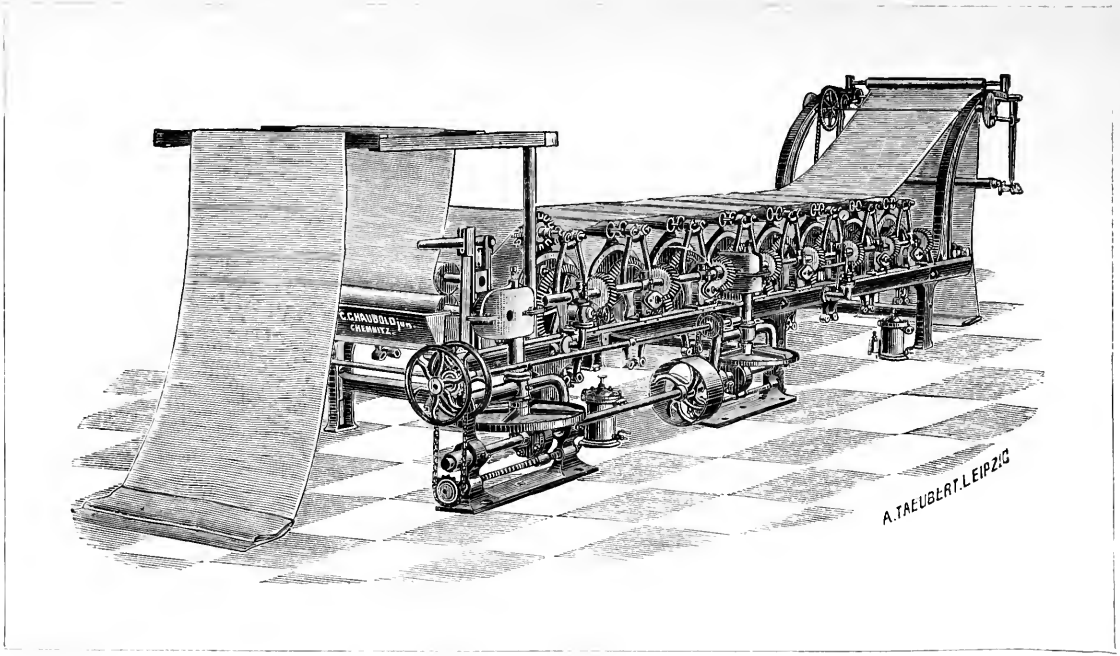

PLATE XXIV.—CYLINDER DRYING MACHINE.

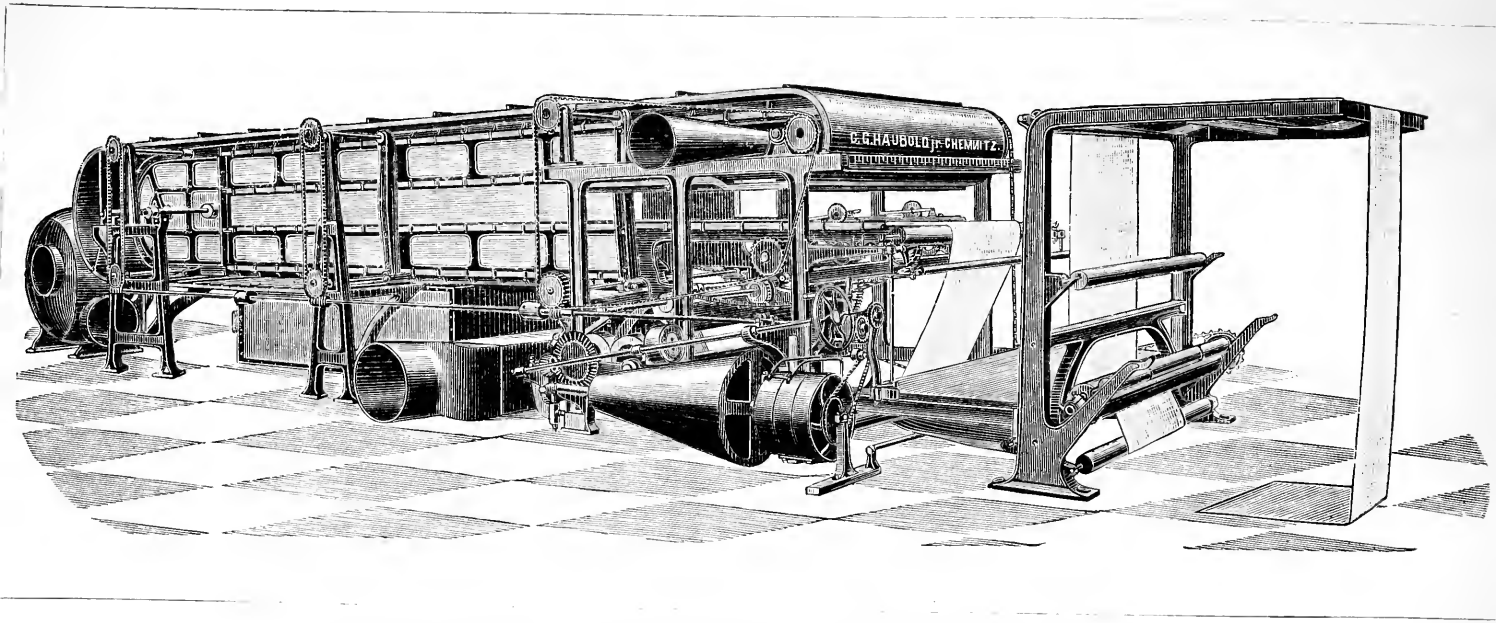

PLATE XXV.—STENTERING AND DRYING MACHINE.

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the author begs to refer those interested in the matter to the fine work published in French by Depierre, "Traité des Appréts des tissues de Cotton," in which all the details are fully described and illustrated.

In the present volume I only give some illustrations of finishing machinery, principally for the sake of reference and general information, and also the illustrations of some of the machines introduced in France for woollen goods, &c., for the same reason.

Plate XXVI., beetling machine.

Plates XXVII. and XXVIII., being finishing machines for velvets.

Plate XXIX., drying and finishing machine for woollen goods, &c.

Plate XXX., gas singeing machine for woollen goods.

Plate XXXI., fixing machine for woollen goods.

Plate XXXII., drying and burling machine for wool extracting.

Plate XXXIII., washing machine for silk yarns.

Plate XXXIV., rotatory hot press, especially suitable for fine woollen tissues and other purposes.

Other illustrations of finishing machinery for cotton goods will be found on the following plates :—

Plate XXXVIII., back filling mangle.

Plate XXXIX., ten bowl calender.

Plate XL., five bowl calender for soft goods.

Plate XLI., combined starch mangle, drying machine and steam engine.

Plate XLII., spray damping and batching machine.

Plate XLIII., three bowl swizzing calender, with gas heating apparatus to metal roll.

I must now refer to the illustrations received at the last moment. From Mr. John Petrie, Jun., of Rochdale, of scouring and washing apparatus for loose wool, as shown on Plate XLIV., and continuous drying machine constructed with continuous feed and delivery, and capable of drying 5000lbs. of wool per day : Plate XLV., Fig. 24, the improved table wool drying machine, also constructed by the same firm.

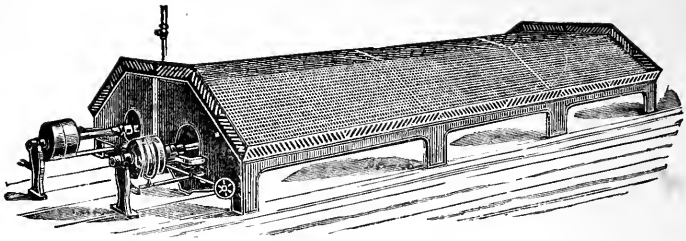

TABLE DRYING MACHINE FOR WOOL.—FIG. 23.

I must express my thanks to those gentlemen, and to the other firms of machinery makers, Messrs. Bentley and Jackson, Messrs. Pierron and Dehaitre, Mr. Haubold, Jun., and Messrs. Mather and Platt, for the information and blocks of illustrations so kindly placed at my disposal.

THE HYDRO-EXTRACTOR.

The hydro-extractor plays a very important part in modern yarn dyeworks, and also in establishments where the loose fibres are being dyed. Among the many machines of different construction, figs. 24, 25 illustrate the "Weston" Hydro-Extractor, which is constructed on the principle of allowing the revolving basket to oscillate within certain limits, so that it may be free to assume, as a centre of gyration, the centre of gravity of the basket and its load, thus balancing itself and reducing to a minimum the power required to drive the machine, as also the amount of vibration transmitted to the frame or building to which it is attached. The basket is not compelled by fixed bearings to revolve about a certain fixed centre, but by the use of elastic bearings is permitted to find its own proper centre of rotation. When the load is evenly balanced, the basket will swing a little at starting, and then spin perfectly true. When there is a considerable inequality in the load, the basket will swing through a longer arc as it begins to revolve, but the oscillations will grow smaller and smaller as the speed gets up. Whenever there is an unequal

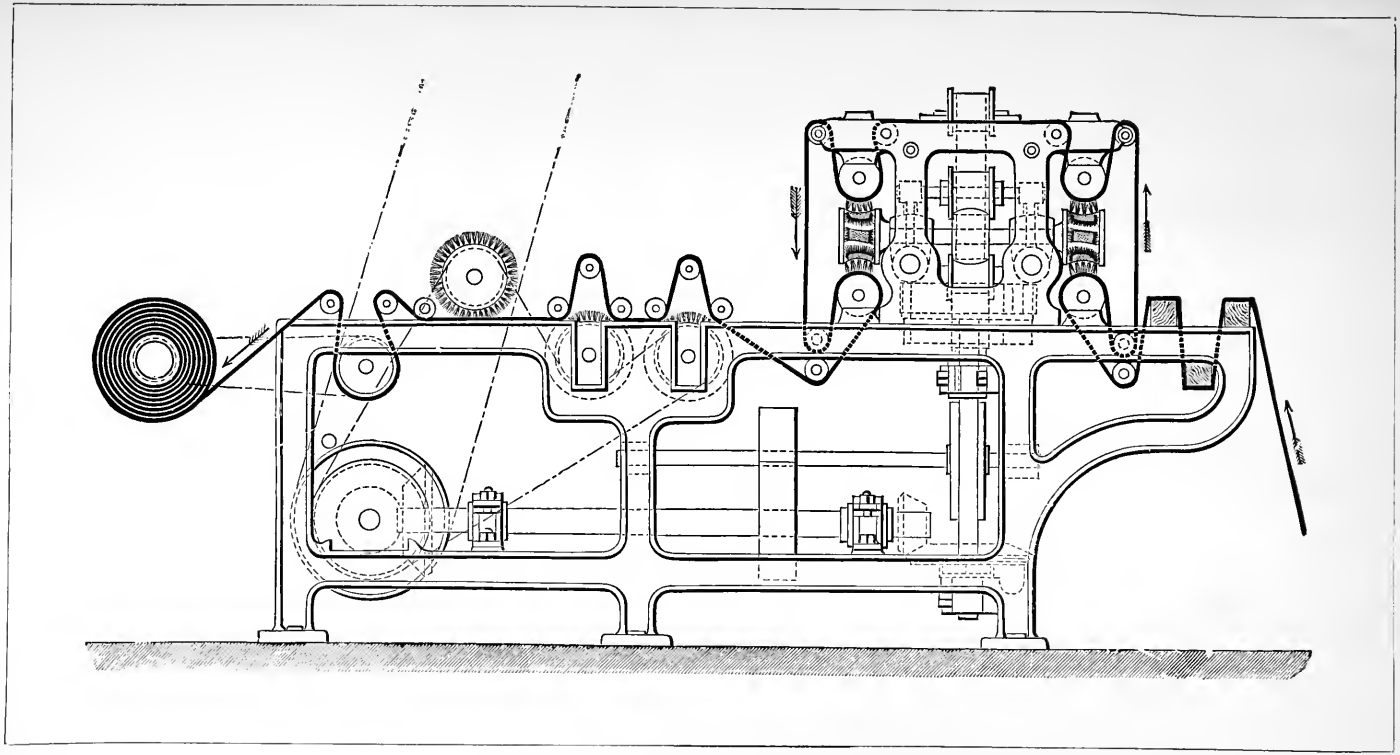

PLATE XXVII.—CROSS-OVER FINISHING BRUSHING MACHINE FOR VELVET AND PLUSH.

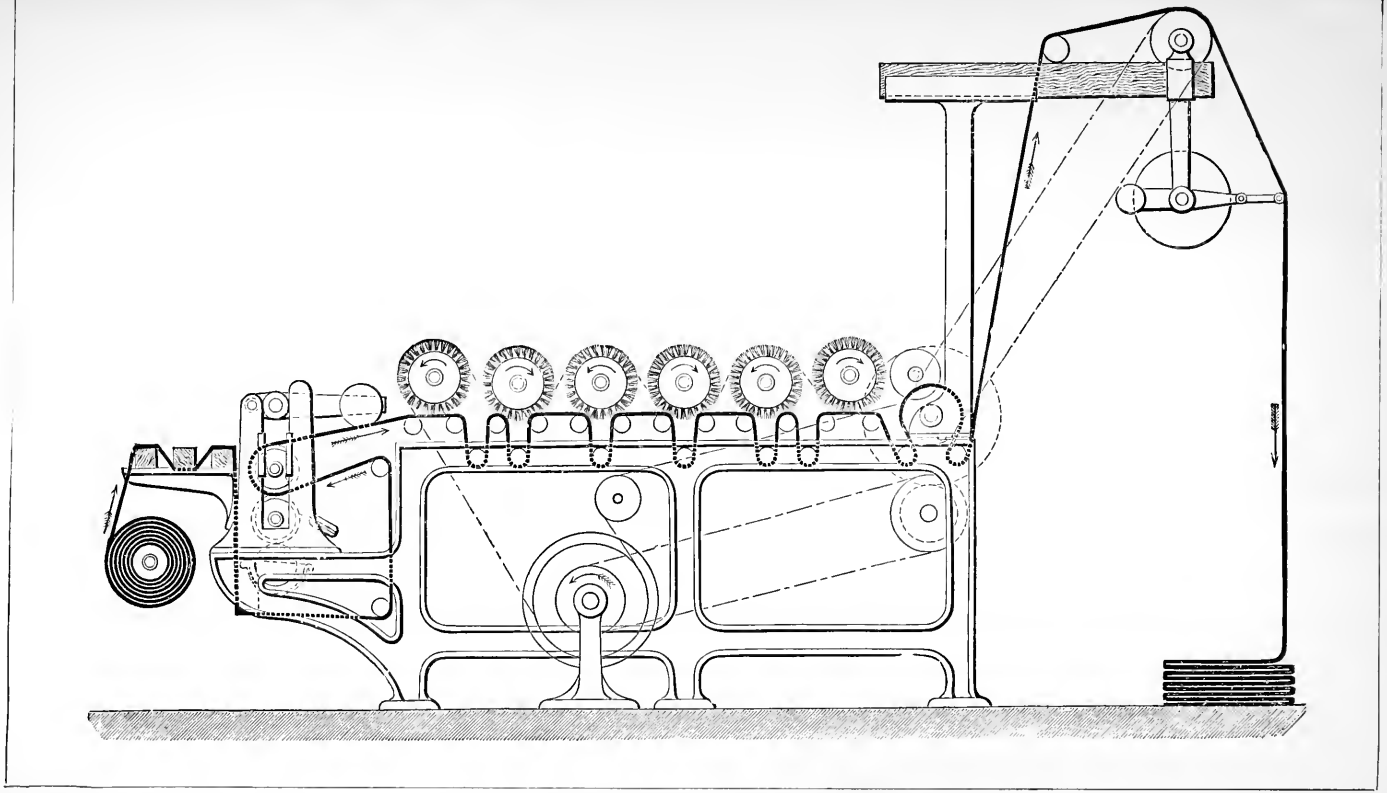

PLATE XXVIII—IMPROVED PRINTING MACHINE FOR VELVETS AND PLUSH.

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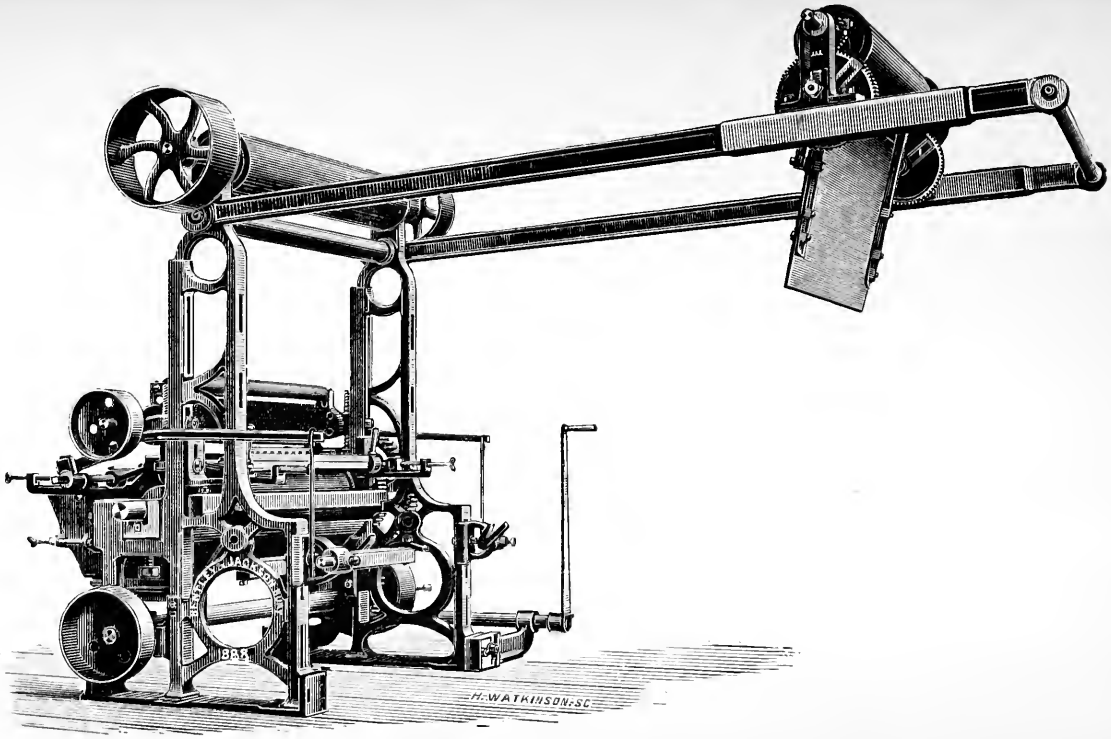


PLATE XXXVIII.—BACK FILLING MANGLE.

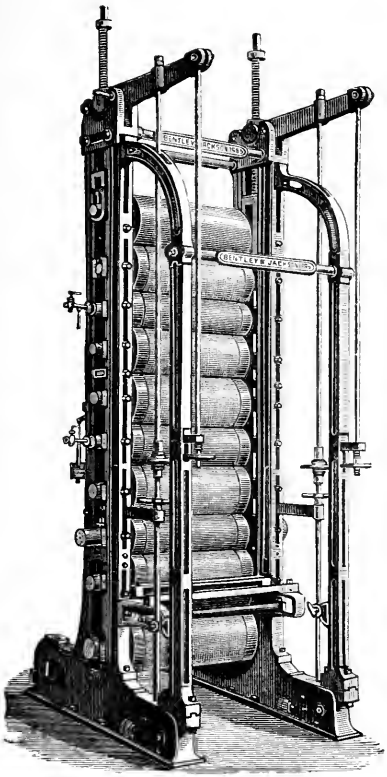


PLATE XXXIX.—TEN BOWL CALENDER.

load there is, necessarily, in every form of extractor, a tendency to oscillate on the part of the basket, and, instead of wasting power and setting up severe strains by trying to restrain this tendency and to hold the basket to a fixed centre, this latter is allowed to go as it likes, within the limits required by practice, and always under the control of the elastic bearings. Vibration in the framing of the machine, or in the floor upon which it rests, is thus prevented by this simple but most efficient expedient, and consequently the massive foundations required for the ordinary class of hydro-extractors can be dispensed with—a fact of great importance.

To Messrs. Watson, Laidlaw, and Co., of Glasgow, I am obliged for the illustrations and details concerning this make of hydro-extractor, which was originally invented by Mr. Weston, of Boston. Fig. 24 shows a machine with suspended cage, of which fig. 25 is the sectional view.

A, spindle on which the cage is suspended; B, bracket; C, supporting column; G, cage; D, outcasing; E, F, fast and loose pulleys; C^1, a hollow cylinder serving as a cover round the shaft or spindle A, to prevent any dirt or grease falling in the cage, which can be further covered up on the top of the casing D.

Fig. 26 shows an underdriven hydro-extractor with engine attached. Fig. 27 is also underdriven, and specially recommended for small establishments, and shows the section of the cage and outer casing.

Before concluding this chapter relating to the machinery and apparatus employed in dyeing industries, I must express my thanks to the machinery makers for their great kindness in allowing me to make use of the illustrations of their machinery, and besides those who have already been named, I must express my thanks also to Messrs. Jackson and Bror., of Bolton, the makers of bleaching, finishing, and dyeing machinery, principally for goods manufactured in the Bolton district, and my regret that I could not insert the excellent illustrations kindly placed at my disposal, as they arrived too late. The large number of illustrations

which the author has been enabled to collect in this work represent a great deal of trouble taken by the different firms of machinery makers, and to them my best thanks are here recorded.

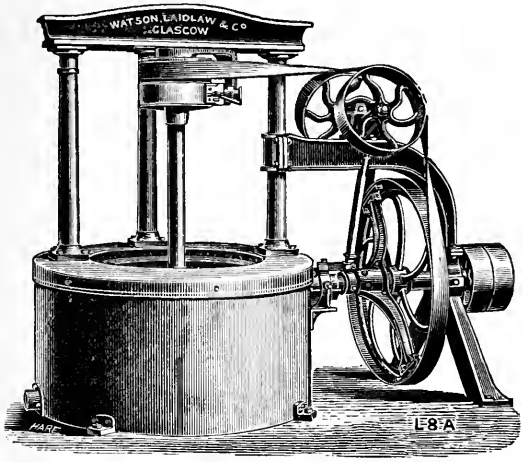


Fig. 24.

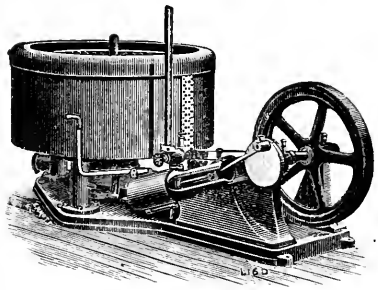


Fig. 26.

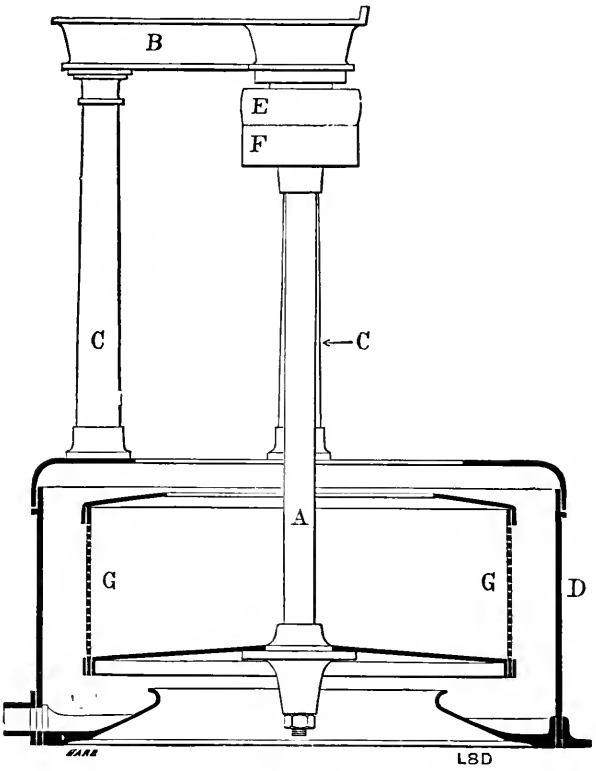


Fig. 25.

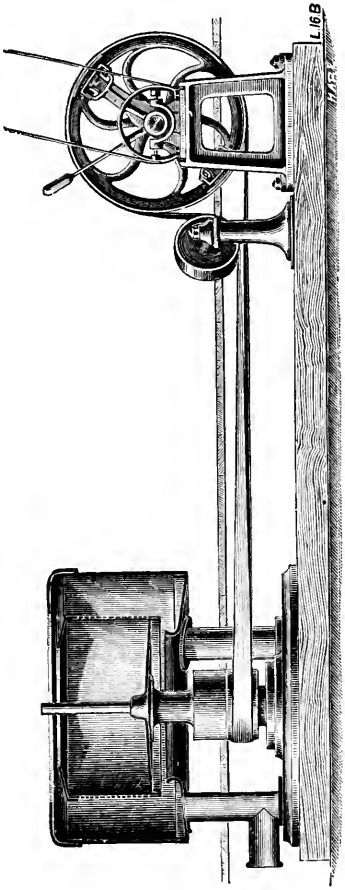


Fig. 27.

EXPLANATIONS OF DYED PATTERNS.

CHAPTER XI.

Pattern Cards I., II., and III.

I am indebted for the patterns on these cards to the kindness of Cavalier E. De Angeli, the energetic President of the Chamber of Commerce of Milan, who has obtained them for me from the two Como firms as below. To him also I am obliged for the complete series of patterns of cotton goods on Cards X., XI., and XII.

Signori Carcano, Musa and Co., of Como, have kindly supplied the three patterns on Card I.

No. 1 Pattern.—(Faille Française) light blue, dyed in the yarn, with water-soluble aniline blue.

Organzine: boiled.
Trame: souple.

No. 2 Pattern.—(Duchesse, paille) straw colour, dyed in the yarn with picric acid and annatto and aniline yellow.

Organzine: boiled off.
Trame: souple.

No. 3 Pattern.—(Polanaise rose vif) dyed in the piece with tannic acid mordant and safranine or magenta, according to shade required.

Pattern Card II.

All the samples, except one, on this card are due to Messrs. Bartolotti and Corti, of Como.

Yellow: dyed in the piece on tannic acid mordant, with auramine yellow.

Bluish grey, piece dyed with mixture of aniline blue, yellow, and red.

Dark navy blue, piece dyed with aniline blue.

Black: piece dyed on iron and tin mordant, with logwood in connection with catechu and prussiate.

Black: combination of aniline (induline) blues, yellow and red.

The fine damask pattern in the middle consists of boiled-off silk entirely.

Yarn dyed with the respective coal tar colours, aniline violet, blue, yellow, and red.

Yellow, is the new azo yellow, dyeing cotton and silk without mordant, kindly supplied by Messrs. Leonhardt and Co., of Mühlheim, under the name of "chrysophenine."

Pattern Card III.

Pink, with coal tar dye, for which magenta, safranine, new geranium pink, eosine, or magdala red could be used according to shade required.

Olive: coal tar yellow and archil.

Light blue, with soluble aniline blue, or with alkaline blue.

Light violet, with methyl violet, red shade.

Red: can be obtained with safranine, etc.

Brown stripes on yellow ground, with aniline colours: blue, yellow, and archil.

Blue, red, and yellow.

Black and white, both boiled-off; black, ordinary iron black with logwood.

Pattern Cards IV. and V.

These fine silk yarn patterns have been kindly supplied by Messrs. W. G. Thompson and Co., of Cooper Street, Manchester, who have gone to considerable trouble and expense in getting them dyed purposely for this work; to these gentlemen also are due nine of the cotton yarn patterns found on other sheets, as also all the patterns on Plate XIV. All the colours are produced by dyeing in a

soap lather, acidulated with sulphuric acid with the corresponding dyestuffs:—

Middleton Green No. 45.
,, Blue for silk 18.
,, Safranine.
,, Blue RS
,, Purple BS.
,, Orange 64.
,, Safranine O.
,, Navy Blue RS.
,, Violet B.
,, Orange RS.
,, Blue BS.
,, Green ABS.
,, Violet xls P.
,, Eosine YS.
,, Yellow R.

Pattern Card VI.

Illustrates the different stages of the linen manufacture, beginning with the unspun fibre, grey, bleached, and coloured yarn, and grey and bleached cloth. All these patterns are due to the kindness of the well-known firm, The York St. Flax Spinning Co., Limited, of Belfast.

Pattern Cards VII. and VIII.

The series of these fine wool damasks, which have been purposely dyed for this volume, has been kindly supplied by the Badische Anilin and Soda Fabrik, and illustrates the result obtained in wool dyeing by means of this valuable class of alizarine colours. A description of the methods of employment, along with some interesting details concerning these dyestuffs, will be found in Chapter IX. I am obliged to the above firm and their Manchester agents, Messrs. Schott, Segner, and Co., for the great trouble taken on this account.

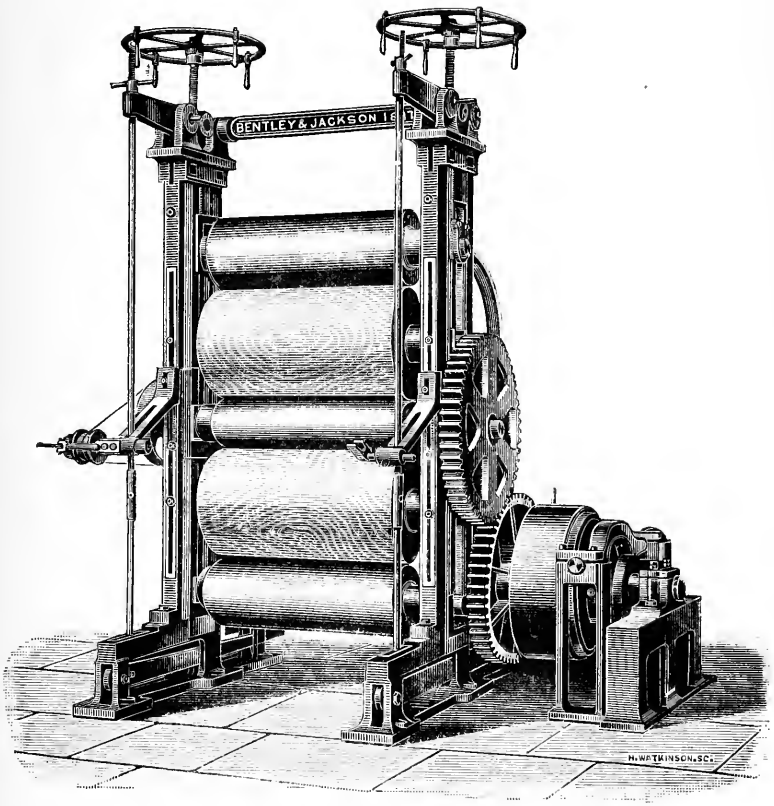


PLATE XL.—FIVE-BOWL CALENDER FOR SOFT GOODS.

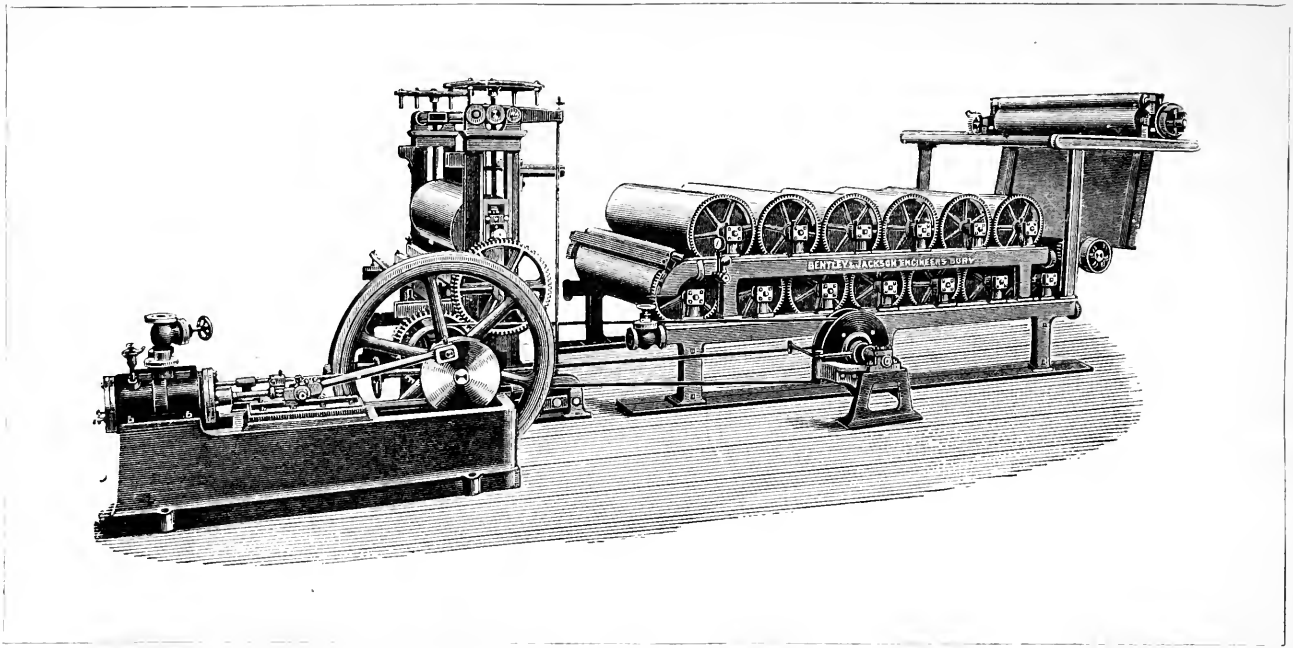


PLATE XLI.—COMBINED STARCH MANGLE, DRYING MACHINE, & STEAM ENGINE.

Pattern Card IX.

The six finely dyed and finished cotton satins are the production of Messrs. Dollfus, Mieg, and Co., of Mulhouse, and are produced as follows:

Green.—Padding of alumina and iron mordant, ageing in the stove, dunging, dyeing with bark and sumac; wash, rinse, and top with methyl green; wash and finish.

Turkey Red.—Ordinary steaming process.

Light Blue.—Mixture of methylene, blue, and violet, printed on one side on the cloth previously mordanted with tannic acid; then steam and finish.

Pink or Rose. — Padded with steam, alizarine pink, steam, &c.

Bordeaux.—Pad in mixture of alumina and iron mordants, age, dung, dye in alizarine by the addition of lima and quercitron extract; wash and finish.

Ficelle.—Mixture of yellow and red ochre, with lamp black fixed by means of albumen and steaming.

Pattern Cards X., XI., and XII.

Due to Signori De Angeli and Cie., from the extensive printing and dyeing works, at the Maddalena, near Milan.

Pattern Card X.

No. 1.—With quercitron bark, tin crystals, and annatto.

No. 2.—Iron buff with nitrate of iron and soda in two separate baths.

No. 3.—Cutch and bark fixed with bichromate of potash and alum.

No. 4.—Cutch, logwood, bark, fixed with alum and bichrome.

No. 5.—Tannic acid and tin mordant, dyed with magenta.

No. 6.—Logwood, bark, cutch fixed with sulphate of copper and bichrome.

No. 7.—Azo scarlet (ponceau) or stannate of soda mordant.

No. 8.—Tannin and tartar emetic mordant, dyed with auramine and malachite green.

Pattern Card XI.

No. 1.—Tannin and tartar emetic mordant, dyed with auramine and methyl green.

No. 2.—Acetate of lead, ammonia, and bichromate of potash (ordinary chrome yellow).

No. 3.—Tannin and tartar emetic mordant, dyed with basic aniline blue (methylene blue and violet, or Victoria blue).

No. 4.—Acetate of lead, ammonia, bichrome, and lime. (Chrome orange).

No. 5.—Logwood, bark, iron acetate, topped with methyl or malachite green.

No. 6.—Alizarine red.

No. 7.—Stannate of soda, nitrate of iron, yellow prussiate, sulphuric acid, topped with magenta.

No. 8.—Aniline black, produced by oxydation.

Pattern Card XII.

No. 1.—Auramine on tannin and tartar emetic mordant.

No. 2.—Iron buff; nitrate of iron and soda.

No. 3.—Cutch, bark, alum, and bichrome.

No. 4.—Cutch, bark, logwood, and bichrome.

No. 5.—Cutch, bark, alum, and bichrome.

No. 6.—Logwood, bark, bluestone, topped with aniline blue.

No. 7.—Chrome orange, topped with an azo orange.

No. 8.—Tannin and tartar emetic mordant, dyed with methylene blue and violet.

Pattern Card XIII.

Loose cotton and loose wool, purposely dyed for this work and kindly supplied by Messrs. Read Holliday & Sons,

of Huddersfield, along with other dyed patterns, and many useful hints and information, for which the author is very thankful, and regrets that he has been compelled for want of room to leave out some of the patterns.

The loose cotton had been dyed as follows:

Yellow—

35lbs. cotton, 1lb. chrysamine, 2lbs. soap, 2lbs. soda, 2lbs. fustic extract. Boil 1 hour, then raise with 2oz. sulphate of copper.

Brown—

(1) 100lbs. cotton, steeped 8 hours; (2) 30lbs. cutch, 1¾lbs. sulphate of copper; (3) 5lbs. bichrome; (4) fill up with 7lbs. fustic extract, 9lbs. redwood extract, and 2lbs. rasped logwood.

Dark Indigo. Bottomed in R. H. & Sons' vat—

22lbs. cotton, topped with 1oz. No. 1 violet 40, and 2oz. No. 1 violet 28, and 8lbs. rasped logwood. Work at about 150° F.

Light Indigo. Bottomed in same vat after last half strength—

22lbs. cotton, topped with 1¼oz. No. 1 violet 65.

Indigo Stain. Bottomed after No. 7, in same bath, half strength—

22lbs. cotton, topped with ¼oz. No. 1 violet 28.

Green—

12lbs. cotton, 6oz. tannic acid, ½-pint double muriate of tin, 2oz. No. 1 fast green 1.

Lavender—

1lb. cotton, 5oz. rasped logwood, ¼oz. fustic extract, 2 drachms No. 1 violet 28.

The patterns inserted in this card are: (on loose cotton) No. 1, grey; No. 2, aniline black; No. 3, light indigo; No. 6, light indigo; No. 5, brown; (on loose wool) No. 4 and 8, dyed in the indigo vat.

Pattern Cards XV. and XVI.

Dyed patterns on jute yarn, kindly supplied by Messrs. Read Holliday & Sons, Huddersfield.

100lbs. jute in each case for weight of drugs specified:

Brown—

20lbs. gambine R. add to bath and bring to boiling point, enter jute, and work ¼-hour, then add 3lbs. bichrome, and work ½-hour.

Brown—

20lbs. gambine Y.; otherwise as above.

Brown—

20lbs. gambine Y., as above, then lift and wash in cold water; next dye in a clean bath with 1lb. maroon orseilline.

Brown—

20lbs. gambine Y., and then in the same bath add 2lbs. bisulphate of soda, and 3lbs. cardinal red.

Green—

20lbs. gambine Y., in same manner as No. 1, only using 5lbs. sulphate of iron (copperas) instead of bichrome.

Crimson Y—

1½lbs. dyed without mordant.

Cerise—

1½lbs. dyed without mordant.

Green P—

3lbs. dyed without mordant.

Indigo Blue R—

1lb. dyed without mordant.

No. 1 Violet 28—

1lb. dyed without mordant.

Pure Blue D.S.—

3lbs.. dyed with 5lbs. alum, and 5lbs. bisulphate of soda.

No. 1 Blue BX—

3lbs., dyed with 5lbs. alum, and 5lbs. bisulphate of soda.

No. 2 Canary—

4lbs. dyed without mordant.

Green Chrystals Y—

1½lbs. dyed without mordant.

Fancy shade—

40lbs. gambine R, half boil, enter jute, then add 5lbs. copperas and work ¼-hour.

Pattern Card XVII.

Dyed Cotton Yarn.—Messrs. W. G. Thompson and Co., have kindly supplied nine patterns, dyed with Middleton

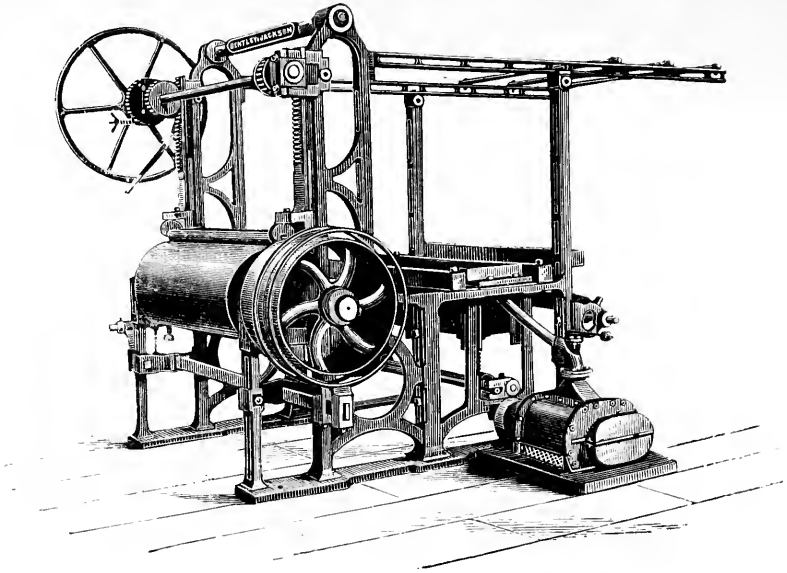
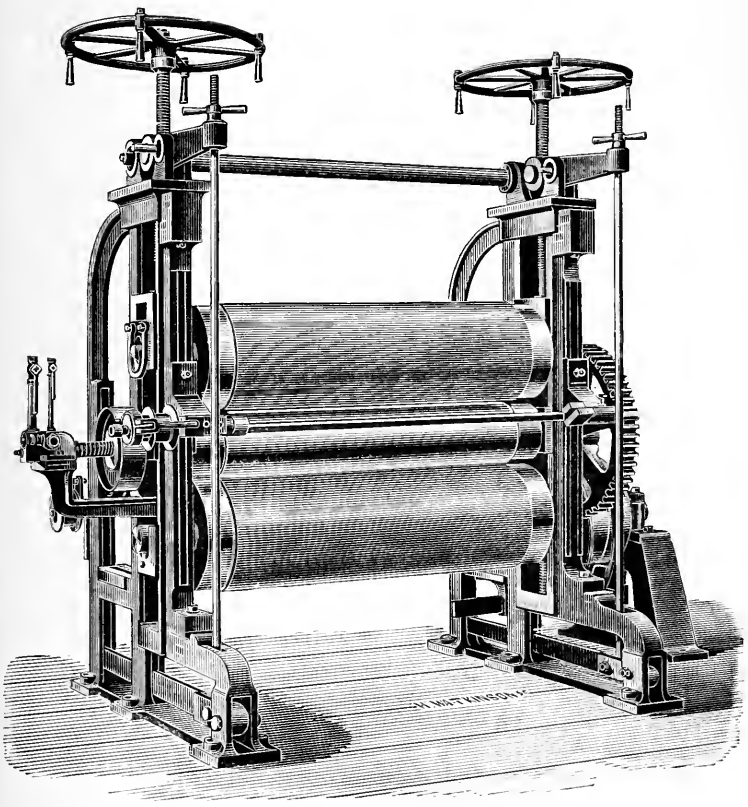


PLATE XLII.—SPRAY DAMPING AND BATCHING MACHINE.



LATE XLIII.—THREE-BOWL SWIZZING CALENDER, WITH GAS HEATING APPARATUS TO METAL ROLL.

safranine, indigo blue A, red C No. 24, green 45, blue GSS, blue G, chromeine, purple, and Middleton blue V, of which Nos. 1, 3, 6, 7, 8 are shown on this plate.

No. 5.—Aniline black, supplied by the Clayton Aniline Co.

No. 4.—Regina purple: Messrs. Brooke, Simpson, and Spiller.

No. 2.—Hessian purple: Messrs. Leonhart and Co.

Pattern Card XVIII.

Cotton Yarns—

No. 1.—Soluble cotton blue: Brooke, Simpson, and Spiller (B. S. & S.)

No. 2.—Indigo: Read Holliday and Sons (R. H. & S.)

No. 3.—Neutral red on tannin mordant: Cassella (Cass.)

No. 4.—New fast blue on tannin and antimony mordant: (Cass.)

No. 5.—Aniline black: (R. H. & S.)

No. 6.—Vacanceine red, fast azo red: (R. H. & S.)

No. 7.—Green 45: W. G. Thompson and Co. (W. G. T. & Co.)

No. 8.—New fast blue, red shade: (Cass.)

Pattern Card XIX.

Cotton Yarns—

No. 1.—Hofmann's violet, tannin mordant: (B. S. & S.)

No. 3.—Opal blue, soap, and acetate of alumina mordant: (B. S. & S.)

Nos. 2 & 7.—Blues, tannin mordant: (W. G. T. & Co.)

No. 5.—Red, tannin mordant: (W. G. T. & Co.)

No. 8.—Chromeine, tannin mordant: (W. G. T. & Co.)

No. 4 & 6.—Vacanceine reds, azo reds formed direct on the fibre, as by Holliday's patent: (R. H. & S.)

Pattern Card XX.

Cotton and Woollen Yarns—

No. 1.—Ingrain red on cotton: (B. S. & S.)

No. 2.—Diamine red on cotton: (Cass.)
No. 3.—Fancy colour on sateened cotton: Kerr and Hoegger.
No. 4.—Milling red on wool: (Cass.)
No. 5.—Hessian red on wool: Leonhardt and Co.
No. 6.—Alkaline blue on wool: (B. S. & S.)
No. 7.—Acid magenta on wool: (R. H. & S.)
No. 8.—Acid violet on wool: (R. H. & S.)

Pattern Card XXI.

No. 1.—Brilliant croceine scarlet on cotton: (Cassella.)
No. 2.—Naphthol black on wool „
No. 3.—Naphthol green „ „
No. 4.—Milling red, G „ „
No. 5.—Brilliant croceine, 9R „ „
No. 7.—Naphthol black „ „
No. 8.—Crystal scarlet, 6B „ „
No. 6.—Dinitroso resorcine black on cotton cloth, kindly supplied by Mr. Horace Koechlin.

Pattern Card XXII.

Contains six pieces cotton velvet dyed with the new series of direct colours, and supplied by Messrs. Bryce and Rumpf, the Manchester agents of the Baeyer Colour Works, of Elberfeld, to whom I am indebted also for the following friendly communication:

The patterns have been dyed as follows:—

Chrysamine—

1 per cent. colour, 10 per cent. phosphate soda, 2½ per cent. soap, dyed at boiling heat as near as possible, without actually boiling.

Benzopurpurine 4B—

3 per cent. colour, 5 per cent. potash, 2½ per cent. soap.

Deltapurpurine 5B—

4½ per cent., same as above.

Rose Azurine B—

4½ per cent., same as above.

Congo Corinth B—

3 per cent., same as above.

Benzoazurine G—

3 per cent. colour, 10 per cent. phosphate of soda, 2½ per cent. soap.

These were all dyed boiling for one hour. This is the actual per cent. colour used in dyeing these patterns. It is no more than just to add that some dyers, who are using these colours extensively, get good and perfectly satisfactory results in the *standing bath* with *much less colour* than the quantities stated. A full shade, for instance, is got in the standing bath with 2 per cent. benzopurpurine, and we know of cases where only 1½ per cent. is used with satisfactory results.

The deltapurpurine 5B and rose azurine G are very fast against acid, much more so than benzopurpurine or congo or benzo. A bath of oleine, mixed with a little soap and soda, when applied after dyeing benzopurpurine materially improves the shade, and renders it *reasonably fast against light.*

The benzoazurine G produces full indigo shades, at a very cheap cost, if the yarn or cloth is first dyed with a weak bath of aniline salts or aniline oil, and then topped with benzoazurine G. This colour so dyed will not turn greenish by exposure to light. It also dyes with logwood extract, and gives cheap results.

Pattern Card XXIII.

Loose wool, dyed with alizarine colours, due to the kindness of Mr. Liebermann, the Manchester agent of the Hoechst Colour Works, from whom are also the following particulars:—

		Mordant.		Dyestuff.
No. 1.	Red.	10 per cent. alum, 6 „ tartar	..	6 per cent. alizarine 1 W.S.
No. 7.		Ditto,		10 „ alizarine 2 abb.
No. 4.		Ditto,		10 „ „ orange.

No. 6. { 3°/₀ bichromate of potash / 2½ °/₀ tartar } 10 per cent. alizarine 2 abb.
No. 3. Ditto. .....10 „ „ orange.
No. 2. Ditto. .....10 „ „ brown.
No. 5. Ditto. .....15 „ „ blue, D.N
No. 8.—Supplied by Messrs. Read Holliday and Sons.

Pattern Card XXIV.

Woollen cloth, due to Messrs. J. Marshall and Son, of Leeds.
169—Orchill extract.
170—Cudbear blue shade.
171—Cudbear red shade
172—Indigo extract, N 1.
173— „ „ N 2.
174— „ „ N 3.

Pattern Card XXV.

176, 177, 178, and 179, due to the kindness of Mr. John Walton, of Collyhurst, Manchester. To this gentleman and to Mr. Downs, the manager, the author is much obliged for much useful practical information, and for permission to visit the extensive works of the firm. They are all iron blacks and specimens of calender and beetle finish.

No. 175, due to the Clayton Aniline Co.; aniline black produced by Mr. Joseph Jackson, Smedley Bridge Works.

Pattern Card XXVI.

These fine series of light fancy shades have been dyed by Messrs. Kerr and Hoegger, of Grimshaw Lane Dye Works, Newton Heath, Manchester. To Mr. Kerr I am especially obliged for much kind attention, practical information, and many useful hints, extending over several years. The shades are produced as follows :—

180—Yellow, with flavine and tin on sumach and tin mordant.

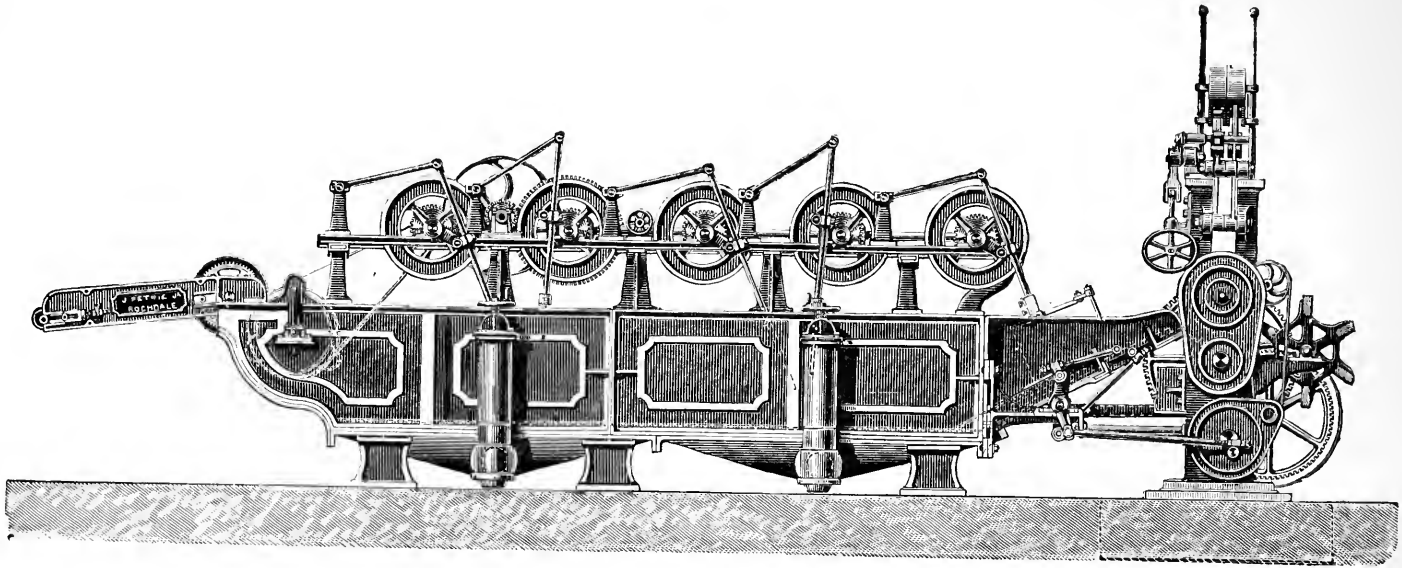


PLATE XLIV.—PETRIE'S SCOURING AND WASHING MACHINE FOR WOOL.

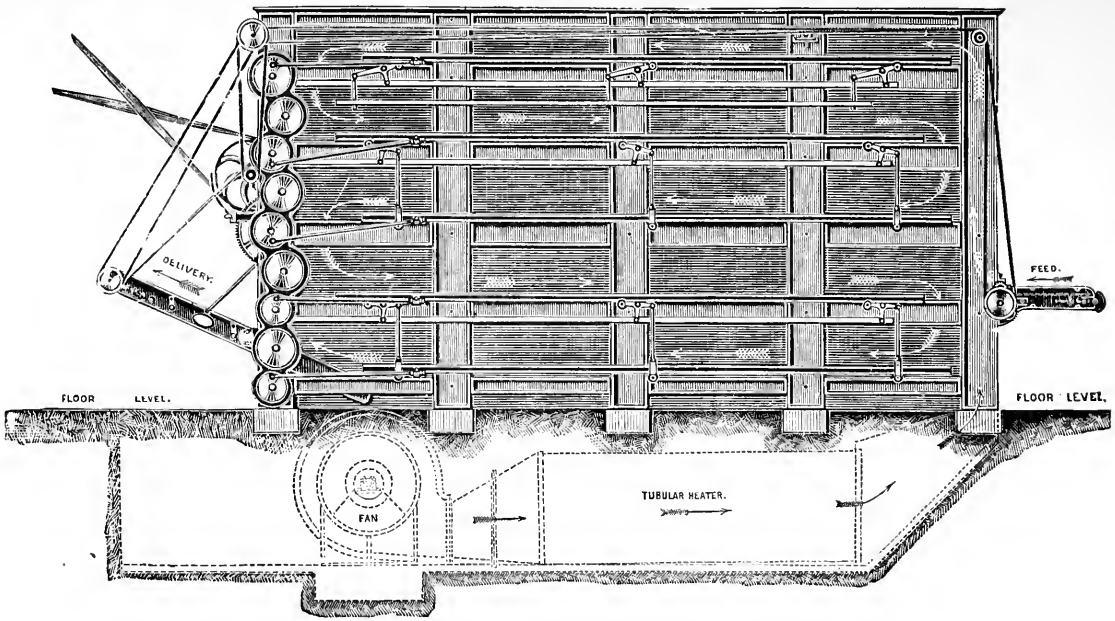


PLATE XLV.—PETRIE'S CONTINUOUS DRYING MACHINE FOR LOOSE WOOL.

181—Drab: cutch iron and chrome.
182—Olive: sumach, iron, alum, fustic.
183—Slate: sumach and logwood, iron, alum.
184—Terra cotta: cutch, chrome, alum, new orange.
185—Olive drab: cutch, fustic, alum.
186—Cuir: cutch, alum.
187—Grey: sumach and vitriol, iron, alum.

Pattern Card XXVII.—China Grass Pattern.

188—China grass as imported, after bleaching.
189—Bleached yarn,
190, 195—Dyed and sateened by Messrs. Kerr and Hoegger, wood and coal tar colours.
190—Bismarck Brown.
191—Slate bottom, sumach, with little vitriol, then iron, then methyl green.
192—Sage, sumach and iron, alum and methyl green.
193—Aniline blue on sumach and antimony mordant.
194, 195—Flavine yellow.

To the following firms I am also obliged for additional information, besides the patterns mentioned above.

From Messrs. Cassella and Co., through their Manchester agents, Messrs. Ch. Hy. Saul and Co.:

Neutral Red; Neutral Violet; New Blues.

To these gentlemen I am obliged also for various other patterns, and much useful information.

I give here some of the details of amount of dyestuff employed in the dyeing of the different patterns which have been purposely prepared for this work by Messrs. Cassella and Co.

Naphthol black B, on serge, dyed with 5 per cent.
Naphthol black 4B, on serge, dyed with 5 per cent.
Naphthol green B, on cloth, dyed with 5 per cent.
Crystal scarlet 6R, on serge, dyed with 2 per cent.
Brilliant croceine 9B, on cotton (piece goods), dyed with about 10 per cent.

Brilliant croceine M, on cotton (piece goods).
Archil substitute I, extra on serge, dyed with 2 per cent.
Milling red G, on serge, dyed with 3 per cent.
New blue B, on cotton yarn, dyed with 2 per cent. } On
New blue R, on cotton yarn, dyed with 2 per cent. } tannic acid
Neutral red, on cotton yarn, dyed with 2 per cent. } mordant.
Diamine red, on cotton yarn, dyed with about 7½ per cent., belongs to the direct class of azo colours, and is dyed in some way without the need of mordant.
Milling red R, on woollen yarn, dyed with 6 per cent.

From Messrs. Leonhardt and Co. has also come the following friendly communication:

New series of colours:—

Red Colours.—Hessian purple B and N, Hessian scarlet.

Yellow Colours.—Brilliant yellow, curcumine S, chrysophenine, Hessian yellow.

Violet.—Hessian violet.

Blue-Black.—Mikado black.

All the above have the property of dyeing cotton without mordant.

The yellow dyestuffs also, with the exception of Hessian yellow, dye wool in an acid bath, fast to fulling.

The reds can also be used for printing on wool, and do not bleed when washed.

Chrysophenine requires especial mention, as it is the only yellow of the Tetrazo class of colours, also called Congo class, that is insensible to alkali. It will not turn red when brought into contact with alkali, which all others do, more or less.

Pattern Cards XXVIII. and XXIX.

Are due to the Berlin Actien Gesellschaft für Anilin Fabrikation through the kindness of Dr. Martius. To that firm and this gentleman I must express my thanks, not only for these patterns, but also for a fine collection of patterns and pattern cards, illustrating the employment of their numerous products on cotton, silk, wool, leather, and even for paper dyeing, which they have kindly presented to me.

The patterns on the above cards have also been dyed specially for this work, and thus bring up to date the latest discoveries effected in the interesting class of direct or substantive azo colours of the Congo series, the manufacture of which was originally started by this firm.

These substantive colours work very well on wool, and as they stand milling can be dyed on woollen yarns which are woven with white in such goods that are afterwards soaped or milled.

Card XXVIII.—Substantive colours on cotton damasks :

196—Congo red N 371.
197—Benzoazurine G 494.
198—Brilliant Congo R 514.
199—Chrysamine R 519.
200—Benzopurpurine 6B 521.
201—Congo corinth B 495
202—Hessian purple N G 488.
203—Olive, mixture of

4 parts chrysamine R
1 part benzoazurine G.

For the methods of dyeing and printing with the above and other substantive colours I beg to refer to a pamphlet published by the above firm—"Instructions for using the Substantive Cotton Dyes," and which they kindly placed at my disposal.

I will only give here a few details relating to the dyeing of the patterns :

Reds.—Congo red, N 371, and brilliant Congo, benzopurpurine, 6B, and others not illustrated here, such as Delta and Rosazurine : as also Congo Corinth.

3 per cent. colouring matter.
2½ per cent. soap.
10 per cent. glauber salt.

Raise to the boil, enter unmordanted cotton, and dye at the boil for one hour. Instead of glauber salt 10 per cent. phosphate of soda or 5 per cent. common soda, borax or

stannate of soda may be used. A passage after dyeing in a 5 to 10 per cent. oleine solution will increase the beauty of the shades.

Hessian Purple.—Bath prepared with sufficient amount of colouring matter and 10 per cent. common salt.

Work at the boil one hour and pass through weak soda bath and dry without washing.

Benzoazurine Blue.—Dye Bath :

10 per cent. glauber salt or phosphate of soda.
$2\frac{1}{2}$ per cent. soap.
2 — $3\frac{1}{2}$ per cent. dyestuff.

Bring to the boil and enter cotton, boil one hour, &c.

Card XXIX.—

204.—Scarlet 2R, No. 234, dyed in boiling bath with the addition of glauber salt and sulphuric acid.

205.—Alkaline Blue 4B, No. 65. Dyed in boiling bath with the addition of carbonate of soda, then followed by fresh bath with sulphuric acid.

206.—Fast blue black, R A, No. 387, bottomed with copperas. Then soured in a new bath with weak sulphuric acid.

207—Chinoline yellow, No. 354. Dyed like the scarlet with glauber salt and acid in dyebath.

208—Guinea Green G, No. 390, with chinoline yellow, dyed with acid in bath as above.

209—Bordeaux S, No. 347, Do.

210—Methyl violet, 4 B, neutral bath.

211—Rubine crystals, neutral bath.

The Manchester Aniline Co. (C. Truby and Co.) promised a series of dyed cotton yarn patterns, illustrating some specialities of coal tar colours, but they were not received in time.

In concluding this reference to the patterns and pattern cards, I must heartily thank all the manufacturers who have given me patterns and information relating to them. They will also excuse me, in cases where I have been compelled, by want of room, not to insert all the patterns supplied.

The collections of patterns, which it has been found necessary to make into a separate volume, represent all the principal dyestuffs employed in the dyeing industries, and will give a good idea of the enormous development attained by the manufacture of artificial colouring matters, and the wonderful achievements of modern colour chemistry.

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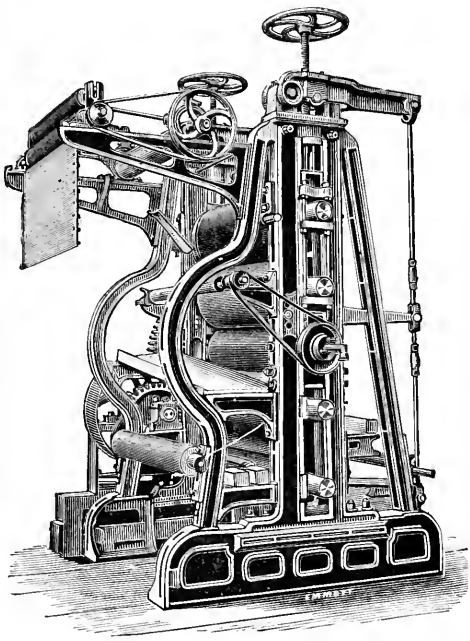

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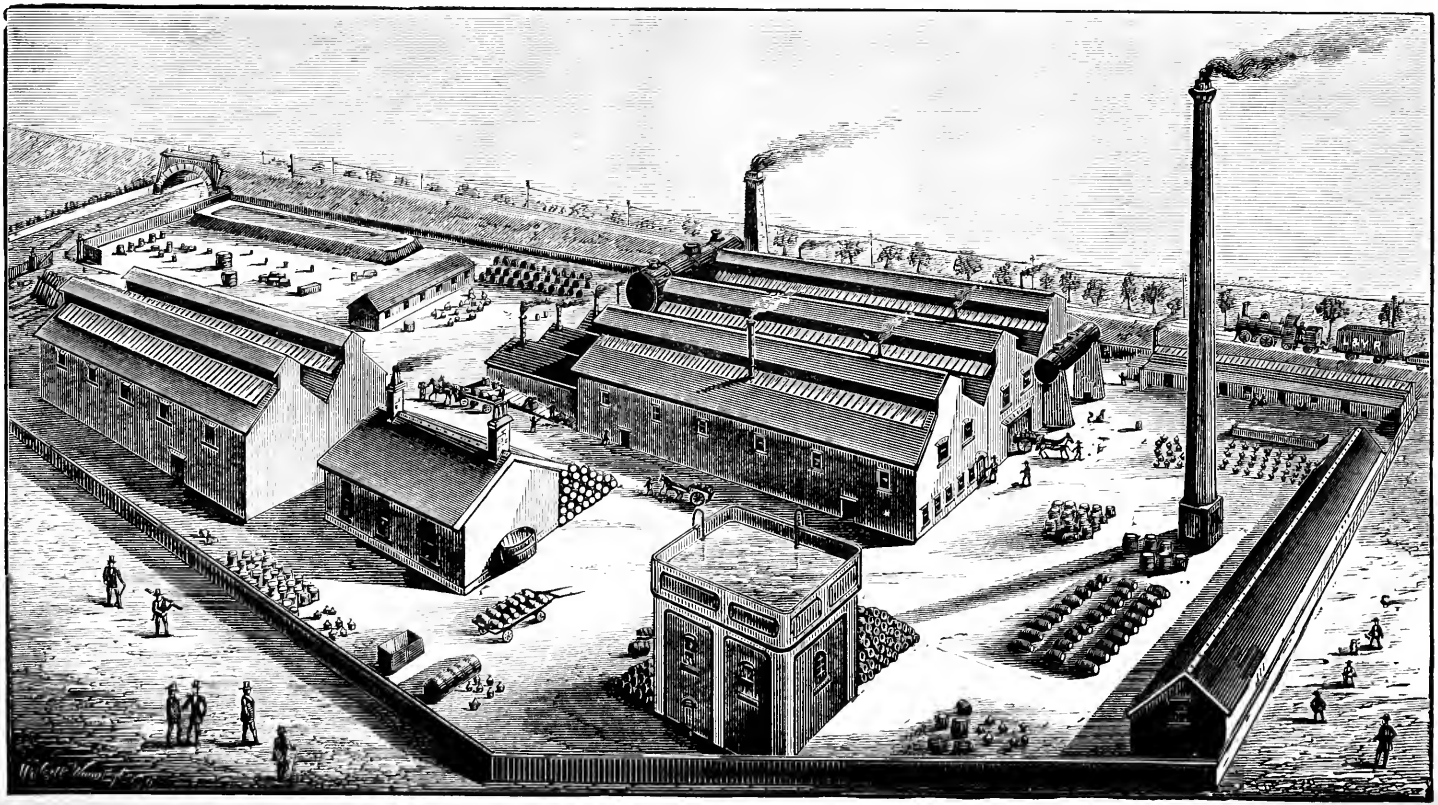

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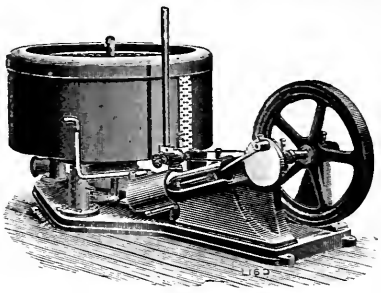

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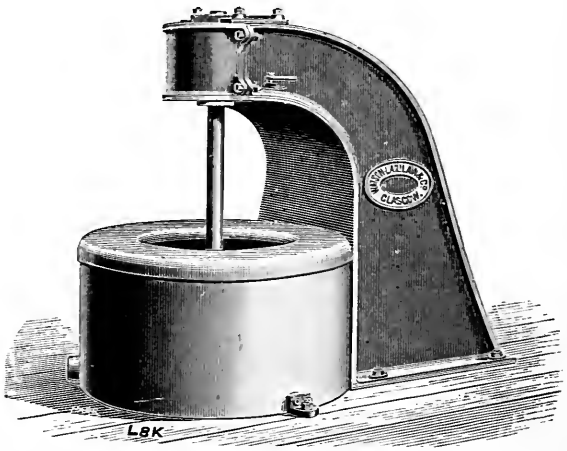

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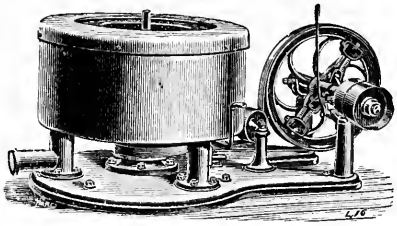

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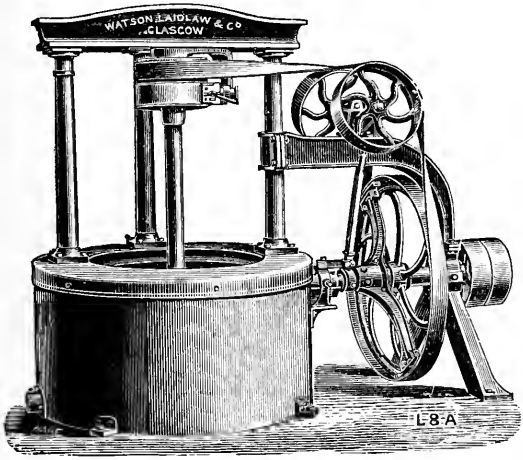

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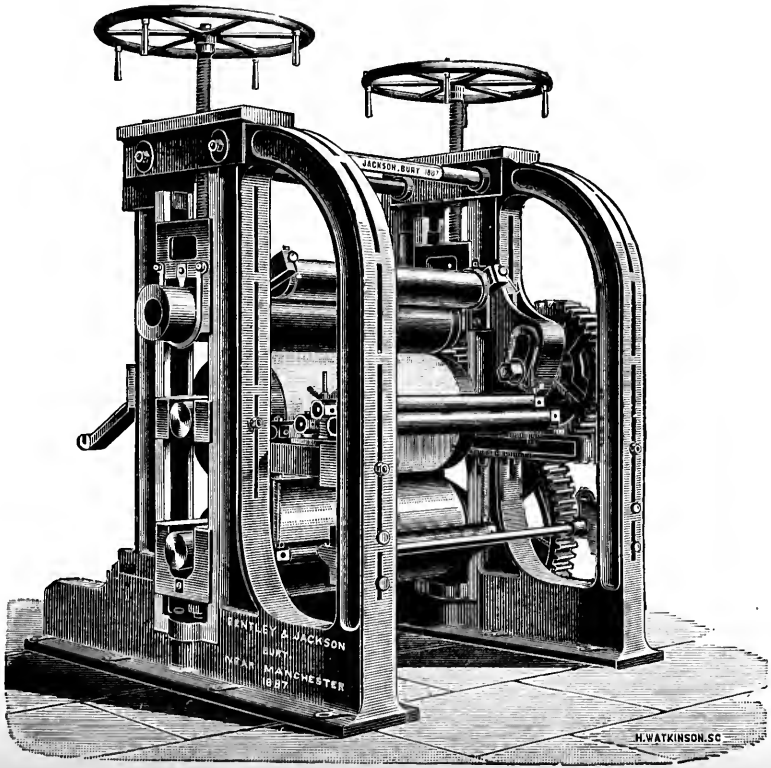

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ANILINE COLOURS FOR DYERS, PRINTERS, &c.

Samples sent on application and matched.

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